S·A·E Journal

JULY
1947

Feature Articles:

Kettering's new engine . . . Truck
Acoustics . . . Ignition Progress . . .
Tomorrow's Air Freighters . . .
Turbojet Installation . . . Bonanza
by Beech . . . Bearing Maintenance

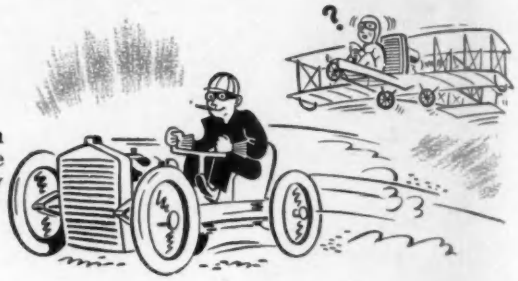
SUMMER MEETING ISSUE

Rumor Page

IT'S RUMORED THAT

planes have always been faster than cars!

Definitely not true! When the Army bought its first plane in 1909, specifications called for a top speed of 40 mph. The auto speed record at that time was 91.4 mph. set by Henry Ford's famous 999 driven by Barney Oldfield.



IT'S RUMORED THAT

a wrought-iron hand-made locomotive piston ring made in 1834 has been discovered!

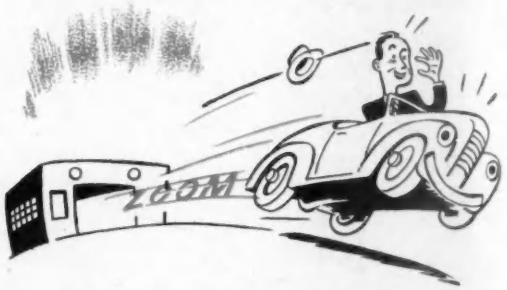
True. According to The Railway Gazette, it was forged and fitted by the driver on an English railway that started in 1834, in the days when the driver was blacksmith, fitter and painter, too. In excellent condition, it is now owned by Britain's Southern Railway.

Contributed by Joseph Tracy, New York, N. Y.

IT'S RUMORED THAT

PC was the first to introduce "K" wall compression rings for higher speed and higher compression engines!

True! Those "K" wall compression rings reduced blow-by, reduced ring groove wear . . . and it took competition three years to learn how to copy it. Just one of many firsts to come from PC's research and testing facilities. If *you* have an engine problem, Perfect Circle Engineers will be glad to work with you toward the right solution.



IT'S RUMORED THAT

there'll be two cars in every garage by 1950!

Now, who do you suppose pulled that old chestnut out of the fire? Anyway, we asked just about every politician we know and, believe it or not, they aren't talking. So just draw your own conclusions.

Perfect Circle Corporation, makers of Perfect Circle *Custom Made* Piston Ring Sets, will pay fifty dollars ($50) for each rumor, fact or fiction, accepted for this page. Send your rumor to Rumor Page, Perfect Circle, Hagerstown 9, Indiana. All contributions become our property and cannot be returned or acknowledged.

The Cover

● More than 1000 SAE members, their wives, and guests attended the second postwar Summer Meeting of the Society in French Lick Springs Hotel, at French Lick, Ind.

The historic hotel, largest available in the United States, is pictured on the front cover of this issue.

In the Cumberland foothills, French Lick has been a popular summer resort since before the Civil War.

A graphic, fast moving report of the 1947 Summer Meeting begins on page 17.

For the Sake of Argument

By NORMAN G. SHIDLE

Good listeners are often more potent than good talkers. It is easy to talk yourself into trouble; hard to listen your way there. Really successful listeners make listening an active, result-getting activity. They keep their brains open, while their mouths are shut.

Few of us have ever mastered the art of listening. If you doubt it, check yourself sometime during a conference while someone else is talking.

Are you actually listening to what is being said?

Or are you running to shut your mind's door to permit concentration on what you so badly want to say as soon as you can break in?

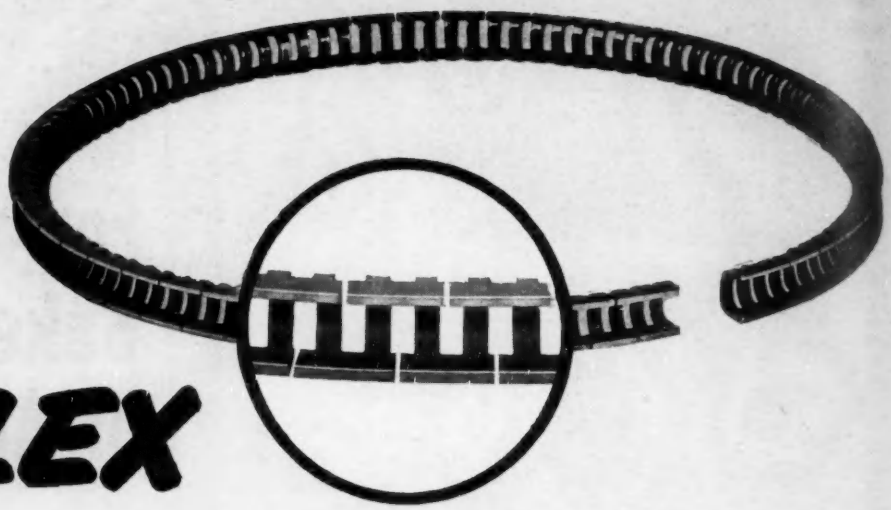
Most of us do the latter . . . most of the time – especially if we are interested in the subject being argued.

Good listeners really listen. They grant new or opposing thoughts the courtesy of a warm welcome, even though they reject most of the visitors as permanent guests.

Good listeners look interested. They stimulate added ideas by pertinent questions; prepare the ground for favorable reception of their own brain-children by patent sympathy for those of others.

Result: good listeners get more information, make more friends, promote more cooperative effort, and have a better chance of presenting their own ideas effectively than do most of us.

The most outstanding piston ring development in 20 years...



The New U-FLEX Oil Control Piston Ring

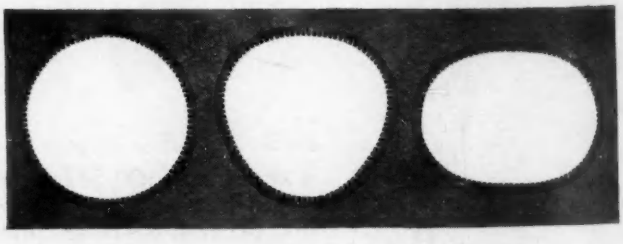
An extremely flexible, one-piece, heat-treated carbon steel piston ring, the U-FLEX sets new standards of oil economy and cylinder lubricating efficiency. The U-FLEX provides live spring action for equalized pressures at all points of cylinder wall without the use of an inner ring.

NEW, RADICALLY DIFFERENT DESIGN gives the U-FLEX flexibility and resiliency never before seen in a piston ring. With the U-FLEX, radial pressure against cylinder walls is uniform, constant. Oil is metered through many fine gaps in the ring in even, parallel tracks.

This steady, controlled distribution of oil means minimum bore and ring wear—with improved performance and oil economy.

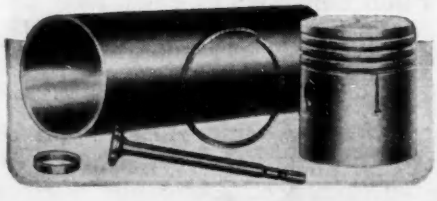
Exhaustive dynamometer and road tests in many makes of engines have proved the U-FLEX superior, even in bores worn to .020″ oversize. The U-FLEX has been adopted by three large engine builders—is being tested by a number of others.

In many applications we believe that the U-FLEX, because of its high oil control efficiency, will take the place of two conventional oil rings in automotive engines.



UNIFORM WALL PRESSURE *is maintained by the U-FLEX through its flexible live-spring action, not only in true cylinders, but in out-of-round or taper-worn bores as well. This extreme flexibility is demonstrated by the U-FLEX rings set in the fixture pictured above.*

Thompson improvements in precision parts engineering include Steel-Belted Pistons, U-Flex Oil Control Rings, Cylinder Sleeves, Valve Seat Inserts, Sodium-Cooled Valves.



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Waukesha
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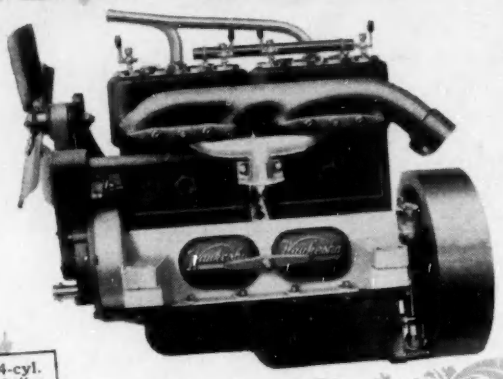

Model L, 4-cyl. 35 H.P., 4¼" x 6¾", 382 cu. in.

THE OUTSTANDING MOTOR *of 1917*

The Waukesha Motor Company is not building pleasure car motors, but is devoting all its energies and resources to the development of the right type of motor for heavy duty service.

Fattening a race horse to give it added weight will never make it suitable for draft horse work, neither will adding weight to a pleasure car motor make it suitable for heavy duty truck or industrial work.

Therefore we have not been handicapped by any inclination to err in the matter of principle but have built solidly, right from the beginning, upon the firm foundation of *correct design*.

The Elements of Design that Have Made the Waukesha Motor Famous

1. Large bearings where needed.
2. Correct distribution of bearing surfaces.
3. Bearing material that excels in strength and wearing quality.
4. Connecting Rod Bearings that do not wear out.
5. Chrome Nickel Steel Crankshafts that stand the wear of bearings.
6. Torque and Power Curves especially adapted to heavy service and ability at speeds that are most used.
7. Speeds of maximum torque and H.P. within the governed speed.
8. Waukesha patented governor that does not fall apart and is lubricated by the oiling system of the motor.

Designed and Built By
WAUKESHA MOTOR CO.
WAUKESHA, WISCONSIN.

an ad with "tell-all" copy **SOLD** this engine **30 YEARS AGO!**

● World Wars . . . I and II . . . have come and gone—but this Waukesha Engine of 1917 goes on . . . and on . . .

But let's hear what Mr. John M. Weed, Superintendent of McAlester Fuel Co., Rockdale, Texas, has to tell us:

"We are pleased that you are able to give immediate shipment of our parts order for "Old Faithful" Waukesha Motor No. 24656 Model L originally sold in 1917, and which we have used since 1919 or 1920.

"The engine is in its original hook-up, that is, it is still driving an Ingersoll-Rand Compressor and, believe me it has made plenty of wind in its lifetime.

"Four years ago while hauling this compressor into our mine pit, the coupling broke and the compressor unit rolled backward, took a sheer drop of fourteen feet, and turned upside down. We turned it over, filled the crankcases, and the gas tank, cranked it up, and much to our surprise and happiness she went back to work making wind.

"The writer has been in this line of work since the age of 16, and in those 40 years or more he has learned that the word *Waukesha* on an internal combustion engine really means something."

WAUKESHA MOTOR COMPANY • WAUKESHA, WISCONSIN
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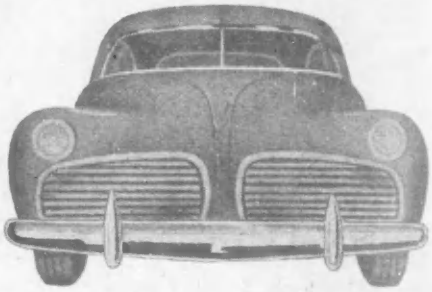
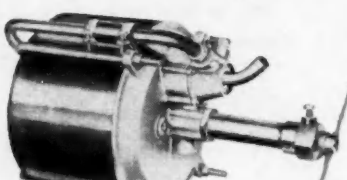
Automotive Vehicles Ever Built have been Better Because of



Bendix Engineering



Hydrovac* scores one more engineering "first" for Bendix. Hydrovac combines in one compact unit all the advantages of previous vacuum power braking systems. With three simple tubular connections, it uses engine manifold vacuum to give smooth, positive brake action with a minimum of driver effort. Already the industry acclaims Hydrovac as "1st in power braking."

The dictionary defines engineering as "the science and art of constructing and using machinery." In no other industry has progressive engineering achieved such outstanding results as in the automotive industry. Bendix* has been the partner of this progress for over thirty years, and has always held a prominent place in the vanguard of new engineering development. Tomorrow, as in the past, the industry can confidently expect the *best* from Bendix—First in Creative Engineering.

*REG. U. S. PAT. OFF.

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SAE Summer Meeting

Kettering high-compression engine top feature. New interest in steam powerplants. Attendance over 1000

THE 1947 SAE Summer Meeting at French Lick will go down in history as the time when SAE Past-President C. F. Kettering exposed to the engineering world his 12.5 to 1 compression ratio engine running on semi-commercial fuel – and gave, perhaps, the greatest of his lifetime of practical answers to the theorists': "it-can't-be-done." (See p. 31.)

Important technical ideas were exchanged on every subject of interest to SAE specialists. New possibilities for steam engines got a dramatic going over. Other unconventional powerplants were studied. Driver comfort, body design, sludge problems, automatic transmissions . . . scores of vital topics were argued.

But on the Kettering engine was focused more attention, discussion and interest than on any single topic at this or any other SAE meeting on record. Announcement of "Ket's" official retirement as General Motors' vice-president in charge of research laboratories came just prior to his appearance at French Lick to add drama to an already exciting occasion.

Comments by leading engineers at the Kettering session swung back and forth between the personality and career of the great scientist and the technical phases of his paper. "The rigor has been taken out of *rigor mortis* and more rigor put into the engine," Roy Cram commented.

Said SAE Past-President A. T. Colwell: "The mystery has been taken out of higher compressions. A bombshell has been dropped here tonight.

SAE Past-President C. F. Kettering (right) and R. E. Wilson, chairman, Standard Oil Co. (Ind.), discuss fuel-engine relationships just prior to the session at which Kettering's paper was read. Wilson, who was chairman of the session, was recently elected to the National Academy of Sciences, of which Kettering also is a member

Now we can all change our viewpoints and raise our sights in designing the gasoline engine of the future."

And, opening the formal discussion period, SAE Past-President B. B. Bachman heralded the Kettering engine as "the first signpost on the road to better engines and fuels."

Said W. J. Sweeney, Standard Oil Development Co. vice-president: "This development appears to prove that properly designed automotive engines of very high-compression ratios can be as smooth and dependable in operation as present-day lower compression engines. . . . We look forward to a period of slow, but progressive, development of engines and fuels which will benefit the consuming public. . . ."

And J. B. Macauley, Jr., thanked Kettering for "coming here tonight to give us a shot of ginger." He added: "This lays the ghost of roughness in high-compression engines and the ghost of excess weight. The wits of engineers, refiners, and chemists must combine to produce the new engine and its fuel."

Kettering summarized his own attitude with: "I would rather have my competitors think I was crazy than to own all the patents in the world."

More than 1000 attended the six-day Summer Meeting, which included a business session at which a series of proposed revisions to the SAE Constitution had their first official reading by Constitution Committee Chairman George A. Delaney.

AUTOMOBILE Engine Lifts the Lid On Compression Ceiling

Based on discussions and four papers presented at two Passenger Car sessions, under chairmanship of **W. S. James** and **G. B. Allen**; two papers presented at one body session under the chairmanship of **J. W. Greig**; and two papers presented at one Materials session under the chairmanship of **T. L. Hibbard** . . . "Clutches for Automatic Transmissions," by **Harold Nutt** and **R. L. Smirl**, Borg & Beck Division, Borg Warner Corp.; "Fluid Couplings for Passenger Cars," by **A. E. Kimberly**, Chrysler Corp.; "Automatic Transmission Control Systems," by **O. K. Kelley** and **M. S. Rosenberger**, General Motors Corp.; "Design Factors for High-Duty Gearing," by **J. O. Almen**, Research Laboratories Division, GMC; "What is Automobile Design for the Future . . . A Science?" by **Virgil M. Exner**, Studebaker Corp.; "Automobile Design for the Future is an Art," by **Kenneth A. Hopkins**, George W. Walker Organization; "Designing and Building the Reinforced Plastic Car," by **L. A. Werner**, Engineering Consultant, and "Automotive Trim Materials," by **V. J. Fisher**, Fisher Body Division, GMC . . . Also includes ideas from the three papers, "Thermodynamics of Vapor Powerplants for Motor Vehicles," by **E. B. Neil**, Consulting Engineer; "Fuels and Engines for Higher Efficiency," by **C. F. Kettering**, Research Laboratories Division, GMC, and "Fuel Injection Engine with Spark Ignition," by **A. M. Starr**, Starr and Sweetland. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

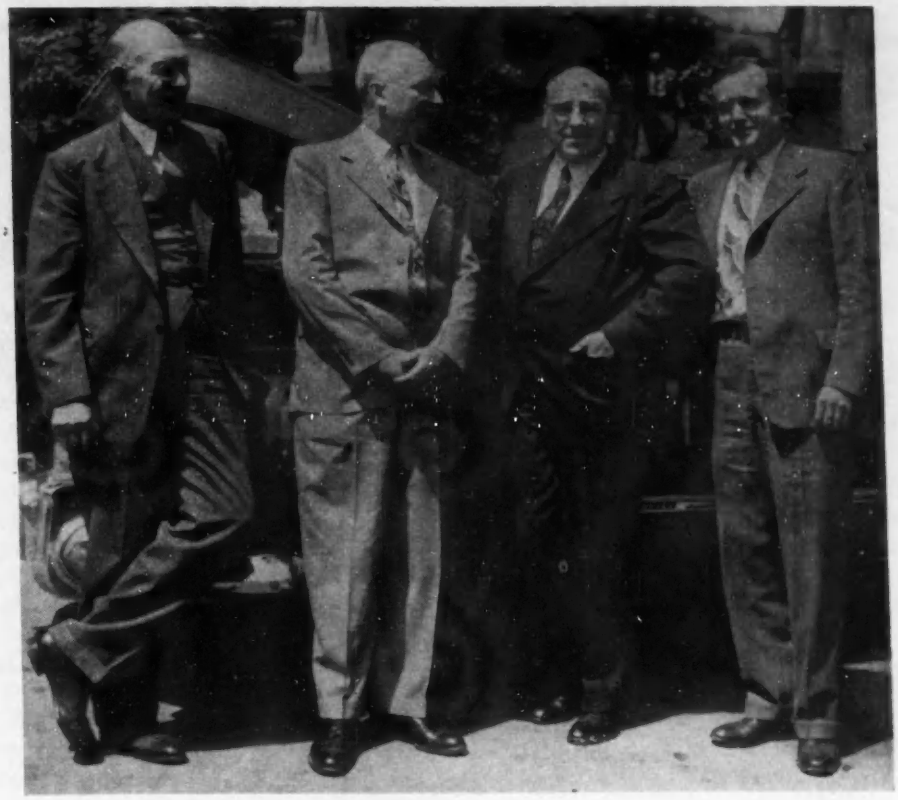
SENSATIONAL revelation of an experimental 12.5 to 1 compression ratio gasoline engine of conventional design delivering 35 to 40% more mpg on commercially feasible 99/87 octane motor fuels opened the door to a new world for passenger car and other engine designers.

The precedent-shattering powerplant and the Kettering researches behind it made clear to everyone that an orthodox engine design and fuel combination – producing vastly greater fuel economy at high compression ratios – is already in the realm of practical automotive and petroleum technology. Commercial realization of the newly demonstrated possibilities, both automobile and petroleum men agreed, will not come suddenly but gradually. The two industries, it was stressed, must march up the stairway to 12.5 compression ratios and 99/87 octane fuels arm in arm. (See p. 31.)

Rapidity with which such high compression ratio engines can work their way into the automotive production bloodstream was said to depend on how soon engine designers gear their thinking to this new concept. Since the 12.5 compression ratio goal must be attained by progressive steps, production tooling considerations require at least one complete redesign of present engines.

Some current engine models, according to between-session comments, may be refined to squeeze one or two more compression ratios out of them. Compression boosts in excess of that call for over-all redesign, in which the attendant retooling will anticipate the ultimate high compression ratio engine.

Economics likewise emphasize the wisdom of gradual improvement in fuel octane number. First, catalytic cracking capacity for large-volume production of the gasoline needed by the 12.5 compression ratio engine is now limited. Second, even if existing facilities were adequate, the higher price of such premium gasoline would unnecessarily penalize operators of the 30 million vehicles



Feature of the SAE 1947 Summer Meeting was the demonstration of the new General Motors 12.5 to 1 compression ratio gasoline engine and the paper "More Efficient Utilization of Fuels," by SAE Past-President Charles F. Kettering, left. With him are President C. E. Frudden, Robert E. Wilson, chairman of the board of Standard Oil Co. (Ind.), who presided at the General Session, and John M. Campbell, SAE vice-president for F & L

now on the road; the added quality would be wasted on current engines.

Unconventional Engines

There was also much interest within the passenger car engineering fraternity in unconventional engine designs.

Attention was given to word that the much-sought-after fuel injection engine for cars with diesel-like part load economy may be nearer than ever before. An experimental spark-ignition engine described operates between a 7 and 10 to 1 compression ratio.

It was said to have the virtues of a diesel plus the advantages of easier starting, greater speed range, lighter weight, adaptability to small engines, and insensitivity to different fuels.

Built of standard gasoline engine cylinder blocks, pistons, and bearings, this 200-cu in. developmental powerplant in a 3400-lb car delivered 30 mpg at 40 mph and about 41 mpg at 30 mph in direct drive. Since the air intake is wide open at all loads, part-throttle economy is not unlike that of a diesel.

Possibility of unreliable ignition at light load caused by too-cool spark plugs was circumvented by the designer with a novel mechanism. It cuts out half of the four or six cylinders at quarter load or less. The cylinders remaining in operation carry sufficient load to insure clean and efficient combustion.

Third in the new engine parade, the old steamer, may emerge in newly clothed engineering and metallurgy minus its old drawbacks, predicted a consultant studying its possibilities.

He contended that the steam engine has inherent advantages over internal combustion powerplants. No clutch or transmission, simple fuel ignition and carburetion should make the engine less costly. And steam engines need be only one-half to one-third the size of equal-output internal combustion types since the vapor powerplant delivers much more power per cubic inch displacement. Higher efficiencies and fewer parts are but a few other advantages.

This engineer believed that the great advances in engineering, thermodynamics, and metallurgy since the old steamer days are adequate tools for design of a practical steam engine that can hold its own with internal combustion powerplants. Modern technical know-how, he said, now possesses the answers to former steamer troubles such as long starting warm-up, fluid freezing in winter, and frequent watering-up.

Automatic Transmissions

Hottest development in car engineering today – automatic transmissions – is being unburdened of operating and fabricating bugs to the point where universal acceptance is almost here, according to reports from three separate sources.

Better performance coupled with convenience is the only justification for automatic transmissions, two designers declared in pointing out that shift control must satisfy this criterion.

The shift control must provide sufficient hysteresis between upshifts and downshifts to eliminate shift hunting, they said. If the designer provides less than 3 or 4 mph between points of upshift and downshift occurrence at the same throttle opening, the semi-automatic transmission will annoyingly keep shifting up and down.

In the Oldsmobile Hydra-Matic, the upshift from third to fourth gears takes place at 65 mph and happens at no higher than 53 mph on the downshift. This spread is desirable to keep the changes in engine sound level from becoming annoying, as well as from a hunt-prevention standpoint.

GOLF WINNERS

•

Men's Championship

Frank E. Farrell

•

Women's Championship

Mrs. H. B. Orr

Engine noise level, these engineers showed, compels a compromise with maximum performance – especially in downshift. Engine speed must not be too high relative to car speed. If it is, objectionable noise level will result. The downshift necessarily produces sudden increase in engine noise and speed. It's much more noticeable than gradual increase in gear during acceleration.

Another engineer claimed fluid couplings will be designed into successful semi- and fully-automatic car transmission for some years to come. Reason: it eliminates bothersome shifting and insures longer drive-train life through shockless power flow. But achieving a practical fluid coupling – both economical to build and reliable in performance – calls for attention to items such as construction, fluid, and slip.

Steel stampings or pressings, he disclosed, have proved reasonable in cost for large quantity production. But the designer was told to provide for minimum speeds without structural failure or deformation. He must be alert to centrifugal bursting possibilities.

While quality engine oil might serve for life of a completely filled unit, oxidation, varnish, and sludge will prevail unless precautions are taken. Answer is use of more highly refined and inhibited oils, changed at frequent intervals.

If dynamometer tests show coupling slip (difference between rpm's of driving and driven members) to be too high, a small increase in outer diameter of the working circuit will reduce it. Slip varies as the fifth power of the circuit diameter.

Whether coming automatic transmissions are fluid coupling or torque converter types, they will have to incorporate a friction clutch in the drive line for shifting out of neutral, two experts observed. This stems from the inherent drag of couplings and converters. It makes good sense, they pointed out, to use this same clutch for starting the vehicle.

One problem with friction clutches is to overcome "bite" at synchronization, after cessation of slip. Caused by a rapid change in torque capacity, this "yank" can be corrected by applying less than full pressure until slip has practically ended.

While the trend toward fully automatic transmissions will eliminate much gearing, design of gears in differentials and rear axles remains a very real problem. One gear designer urged throwing textbook design formulas out the window.

He said that finding out what the gear wants to do rather than telling it what to do is paying dividends in automotive design. Successful predictability is the key to gear design. Classical formulas fall short in this respect. Factors must be found that indicate actual gear performance. These indexes, many of which have been determined, need not be mathematically rational. They are expedients for improving prognostication of gear performance.

Such factors are used in determining gear fatigue, scoring, and pitting. For example, the product of gear tooth pressure, sliding velocity, and temperature is a reasonable design index to scoring for some gear types. But it was cautioned that an empirical formula that works for spiral bevels will not apply to helical or spur gears.

This design philosophy disclosed that a short gear addendum and large pinion addendum reduce scoring, or at least keep it uniform.

Styling Changes Forecast

While evolution rather than revolution will continue to govern coming car designs, war-developed manufacturing techniques and engineering knowledge will give the designer wider berth in styling. But this advantage, according to one passenger car engineer, is temporarily offset by increased labor and material costs.

He argued that designers must recognize the futility of art-without-function and warned airbrush artists to observe the unyielding economics of car manufacturing. The vehicle must be easy to produce and reasonable in price.

Upholding the other side of the eternal car design controversy (analagous to whether the chicken or the egg came first), a designer struck back with a recitation of industrial design's role in converting ugly-shaped vehicles of yesteryear to produce present-day products of beauty. Styling, he predicted, will continue selling efficiency

and added utility in terms of more luxury, greater eye-appeal, and correct contours.

Discussion from the floor accused both art and science of going overboard on looks at the expense of utility. Instrument panel chrome that blinds at night, poor visibility, and glare-producing windshields were offered as evidence of present design inadequacies. First horseless buggies, it was said, gave truly full visibility. Examination of today's models proved to this discusser that design-for-visibility has retreated, not advanced, since that time.

Art, Science, Agree

Art and science gazed into the crystal and the future car looked somewhat alike to both. Functional attractiveness will predominate.

With stronger and lighter engines, more of the car will be in back of, and less in front of, the driver. He will see better where he is going and what is behind him. Expanded interiors, lounge-car seating, air conditioning, and seats convertible to berths will be housed in safer and more luxurious vehicle packages – designed according to good taste and practical engineering.

Such advancements are incorporated in an experimental plastic car described by a consulting engineer. Air-bellow springing for riding comfort, a roomy interior with movable chairs, a rear seat for sleeping, and a rear engine installation affording greater driver visibility are but a few of its features.

The plastic body of this chassis-less car is designed as a monocoque structure to carry all chassis loads. The body material consists of glass cloth sandwiched between polyvinol sheets. Properly cured, this thermosetting resin laminate develops terrific impact resistance and makes for a very rigid structure. It saves weight – especially in fender, deck, and door construction.

Principal stress member, the floor, is constructed of a 2-in. thick honeycombed structure of the same plastic laminate.

Not so dramatic as plastic cars, but important to present-day car designers, was a down-to-earth discussion of the coming type of fabrics for interiors. A specialist revealed that much-advertised "fabrics of the future" – cleaned with a damp cloth and wearing longer than the car – are still the object of experimental searching.

But some constructive improvements are on the way, he felt. Fabric wear will be extended; the material will be more comfortable to sit in. Driver and passenger will more easily slide across the seat, and resistance to soiling plus better cleaning characteristics can be expected.

Handling Payload Key to Streamlined AIR TRANSPORT

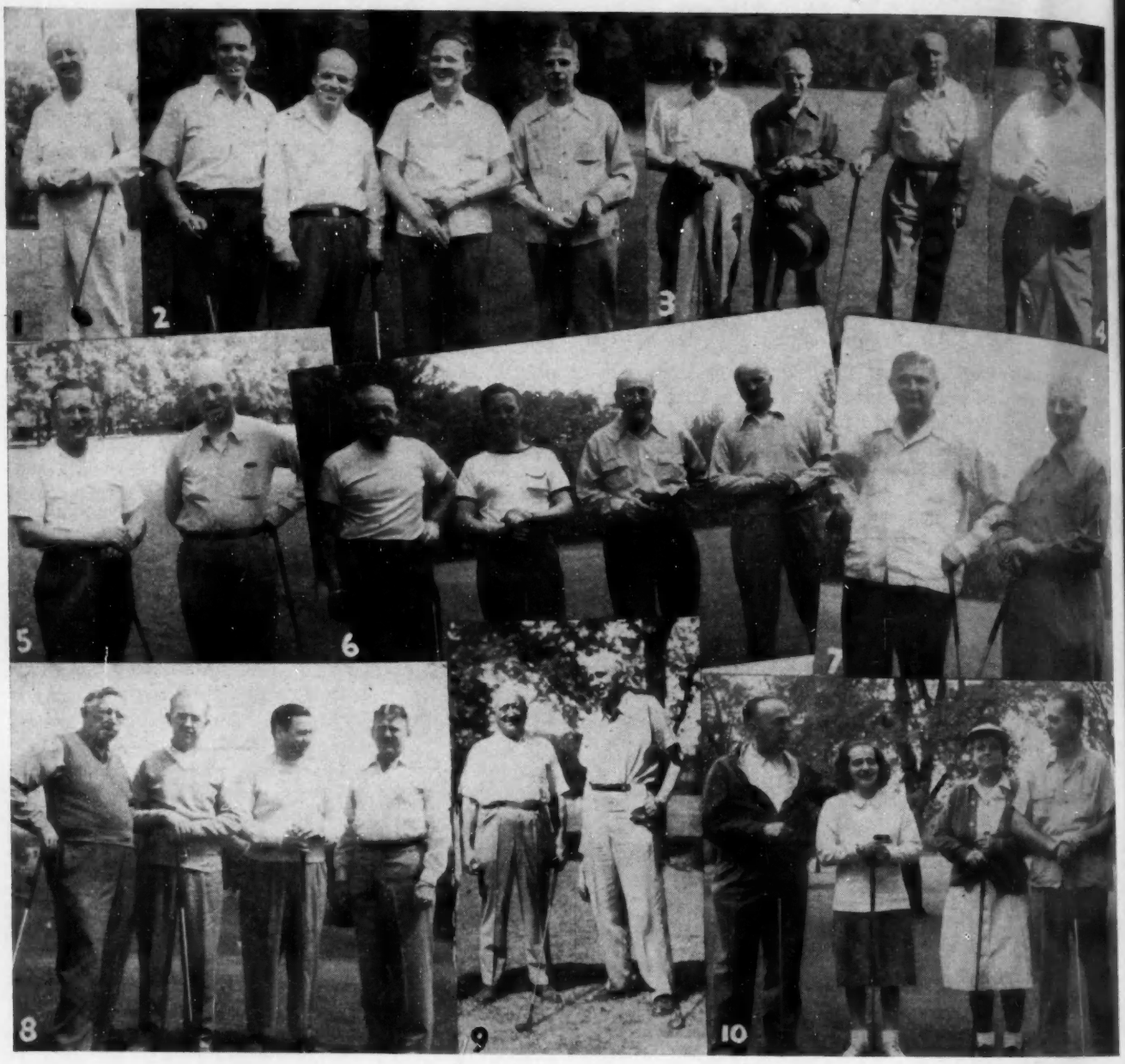
Based on two papers presented at one Air Transport session, under chairmanship of **L. G. Fritz** . . . "Should Freight and Mail be a Separate Operation from Passengers?" by **C. P. Graddick,** United Air Lines, Inc.; and "Some Technical Aspects of Passenger Handling," by **R. W. King,** American Air Lines, Inc. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

ADVOCATES of carrying air freight and mail together with passengers chalked up a round for their side in the controversy between scheduled and unscheduled airline operators, as far as speakers at French Lick are concerned. As forceful as the passenger freight argument was discussion of standardized passenger handling operations urged at the same gathering.

Combining freight and passenger traffic, proponents argued, would increase cargo safety because the planes would have the high standards of passenger aircraft. Economies would accrue because combined services would justify more flights per day – and combined operations would make maximum use of each airline's facilities.

Savings contemplated by eliminating engineering departments from streamlined air freight organizations were labeled senseless thrift. One airline's engineering department, a speaker declared, has already developed enough dollar-making ideas to pay its salaries for years to come.

It was granted that nonscheduled operators filled a real need in the past few years. They flew freight for which scheduled airlines had no capacity and developed cargo-by-air business to some extent. This was so because airline management decided



Among the participants in the 1947 Summer Meeting Golf Tournament were:

1. Harold T. Youngren;

2. E. F. Riopelle, Walter G. Patton, J. R. Splitstone, and D. K. Tippy;

3. A. B. Marshall, H. A. Carison, and J. T. W. Moseley;

4. E. W. Austin;

5. T. F. Schrag and H. C. Snow;

6. Van C. Worden, J. J. Cooper, Dale Roeder, and William S. James;

7. George T. Hook and William E. Conway;

8. J. F. Winchester, Richard C. Long, P. E. Tobin, and F. O. Terrill;

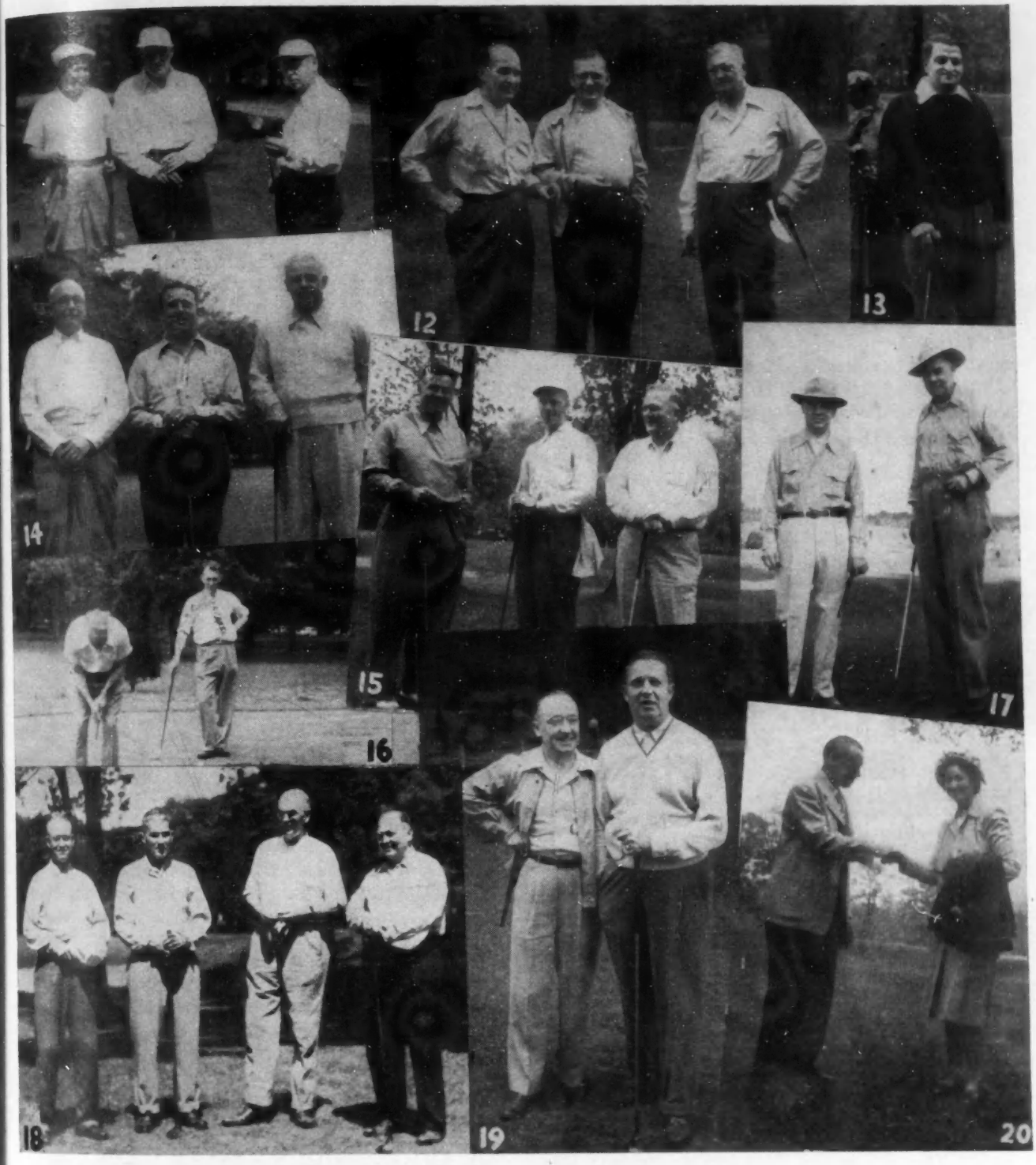
9. Neil Petersen and Marcus Brown, Jr.;

10. H. O. Johnson, Mrs. R. S. Huxtable, Mrs. H. O. Johnson, and R. S. Huxtable.

11. Roy S. Sanford, Edward D. Herrick, and O. K. Kelley;

12. William H. Taylor, Jr., William E. Buttriss, and Walter C. Voss;

13. Dan Dyer;



14. E. T. Vincent, S. C. Merrill, and Furber Marshall;

15. P. E. Bardsley, J. Ottmar, and J. H. Bolles;

16. R. J. Waterbury and J. W. Greig;

17. F. B. Herz and P. H. Chapman;

18. Frank C. Barrows, Jr., Vincent C. Young, Frank Jardine, and Roger L. Weider;

19. E. P. Lamb and S. C. Merrill;

20. Golf Tournament Chairman Fayette "Cy" Leister congratulating Mrs. H. B. Orr, winner of the Golf Championship. Not shown is Frank E. Farrell, men's champion, who also won last year's tournament, and Robert Wingerter, runner up.

to allocate available facilities to passengers first; the demand was terrific. And airlines could not afford to buy surplus planes at bargain prices instead of waiting for postwar air transports on order.

But from a long range standpoint, duplication of scheduled service and overexpansion in the cargo field would speed airline operators toward the brink of bankruptcy.

Whether separate or with freight, passenger handling operations need standardization to bring efficiency, it was agreed. Equipment, facilities, procedures, and appearance . . . standardization all along the line was recommended. Flexibility for constant adjustment has to go along with standardization, though, to meet public demand and to get desired service-cost ratios. It was brought out that:

Particular attention must be paid to the limited number of seats available for sale to establish a fully flexible system of seat space distribution to all cities receiving demands for reservations on any given flight.

A "sell and record" system, adopted by several airlines, places selling agents in each city to make sales on the flight and immediately report by special telephone lines to a central point, which has the entire inventory of seats for that flight. Sales are stopped when agents are told that no more seats are available. The communications system was called the key factor, for it must not break down under even the heaviest load.

There also appears to be much room for improvement in ticket and cash handling. The average ticket seller was reported as spending 1 hr per 8-hr day reconciling tickets and cash. An efficient and economical ticketing machine was suggested as a solution.

Fuels, Engines for Higher Efficiency, Today's Sludge Feature Sessions of F & L

Based on discussions and three papers presented at two sessions on Fuels and Lubricants and a General Session under chairmanship of **J. R. Sabina, S. W. Sparrow,** and **R. E. Wilson** . . . Sludge Symposium: "Effect of Fuel on Engine Varnish and Sludge Deposits," by **W. J. Backoff,** Pure Oil Co.; "Field Testing of Motor Oil and Gasoline," **A. C. Pilger, Jr,** Tide Water Associated Oil Co; "Investigation of Factors Affecting Formation of Low Temperature Engine Deposits," **E J. Bowhay** and **E. F. Koenig,** Texas Co.; a film showing the Effect of Lubricating Oil on Engine Cleanliness (no paper) presented by **F. C. Burk, C. H. Van Hartesveldt,** and **J. C. Geniesse,** Atlantic Refining Co., and "More Efficient Utilization of Fuels," by **C. F. Kettering,** General Motors Corp. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

DOORWAY to increasingly higher octane fuel ratings was swung wide open at the General Session when a 30-year research program evaluating the future was presented to an overflow technical session. Two Fuels and Lubricants sessions were devoted to sludge, varnish, and other engine deposits with the general conclusions that until some improvements are made in engine design, the burden of clean powerplants will continue to rest on the shoulders of maintenance men.

Although petroleum technologists usually agree that the octane number is higher by from 0.1 to 1 point than the motor cars of any date really need, the report of single cylinder and record of two experimental cars clearly and dramatically demonstrated that the refiners have a vast program of research, development, and refinery installations ahead of them.

Discussions following the epochal disclosure of the successful 12.5 to 1 ratio engines indicated again that there is little agreement among experts on the nation's oil reserves, but a prospect of saving that reserve by one-third via increasingly higher octane numbers in motor car fuel was a challenger to even closer cooperation between the automotive engineers and petroleum technologists.

Beginning with triptane, a fuel so good that no engine built could but operate with it in the fuel tank, the research report showed that a 15 to 1 ratio and higher was possible with that rare hydrocarbon, but that something under commercially available aviation fuels of today would operate a 12.5 to 1 engine at a fuel saving of from 35 to 40 mpg. The laboratory and road test data were obtained on a sensitive catalytic cracked gasoline with 1.5 mm of tetraethyl lead with a Research octane of 99 and an ASTM of 85. Slight detonation occurred with the 12.5 engine above 55 mph.

Several discussers conceded that, with the theoretical lid removed from higher compression gasoline engines, the two industries are in a position

Chairman of the daily Women's Bridge during Summer Meeting week at French Lick Springs Hotel was Mrs. P. H. Oberreutter, right, who donated door prizes each day. Several tables of players are shown at the left. More than 250 wives of SAE members attended the meeting, the largest group on record

to go up the steps toward higher octane together.

As one petroleum technologist pointed out, so much advance had been made in refining during the past five years in the interest of winning the war, that programs heretofore appearing impossible now are in actual prospect.

What of sludge and the high compression gasoline engine of the future?

Because of complete fuel combustion, there should be no soot problem such as is faced in diesel engine operation, a number of experts believe. Because of lower heat rejection, the colder engine's prospects appeared more happy in respect to cylinder varnishing, others said in the many informal discussions in the hotel lobby, verandahs, and dining room.

Ideas were advanced cautiously, even by those who had worked closely with the development program, because mileage has been insufficient to hazard much more than educated guesses.

Sludge and Varnish

Operators of the millions of vehicles on the highways today were told in a two-part symposium on Sludge that, although more investigation is needed, main factors to reduce sludge and varnish deposits in engines were slight design modification in engines, improved maintenance routines, and a better control of fleet operations. Importance of more field test data was emphasized repeatedly.

The four papers which substantiated these conclusions were written by seven outstanding petroleum technologists, and contributions to their presentations were made by numerous experts and considerably intensified programs of the Coordinating Research Council, a group supported jointly by the SAE and the American Petroleum Institute.

Elimination of low temperature engine deposits is so complex, and is so greatly affected by numerous variables, that a complete solution is not expected to be found by altering or correcting any one existing condition. Although there was no agreement as to the order of importance of the conditions mentioned, most of the authors stressed improved maintenance, and agreed that better procedures must bear the brunt of engine deposits.

Fleet operators, on the other hand, believed that too much time and money now goes into engine maintenance.

In a progress report of the CFR Engine Varnish and Sludge Group, it was demonstrated that different fuels exhibit markedly different tendencies to sludge and varnish in engine interiors. Field service tests and the FL-2 method also disclosed that further work must be done on distribution of diolefins, volatility, and copper-dish gum investigations.

For the operator of vehicles performing intermittent service, such as door-to-door deliveries and taxicabs, some relief from heavy sludge deposits was seen in fuels assuring more complete combustion, and the use of additives to dissolve and hold in suspension soot and other products of incomplete combustion.

Although they have proved their value as an aid in reducing sludge and varnish in engines, the heavy duty oils cannot be expected to "digest" excessive amounts of these materials, several of the authors pointed out. Their power to dissolve and suspend is limited, and, as one of the authors described the phenomenon, they soon "wear out" when excessive unburned residuals get into the lubrication system.

Likewise, the ability of additives to inhibit polymerization of these materials is limited, although they have been effective in reducing varnish until that limit is reached. When exhausted, oil draining and change are mandatory.

Operators seeking relief from the added burden of maintenance caused by the tendency of engines to sludge and varnish were assured that, at least, the premium and heavy duty lubricants are a step in the right direction, but at this stage of development, a relief that has been oversold.

T & B Speakers Show Designers How Metallurgy Pays Off

Based on discussions and two papers presented at two Truck and Bus sessions, under chairmanship of **M. C. Horine** and **F. B. Lautzenhiser**; two papers presented at one Materials session, under chairmanship of **C. J. Tobin**; and one paper at one Body session, under chairmanship of **K. E. Coppock** . . . "Thermodynamics of Vapor Powerplants for Motor Vehicles," by **E. B. Neil**, Consulting Engineer; "Rubber-Tired Hauling Equipment for Off-the-Highway Service," by **H. L. Rittenhouse**; "Proper Use of Spring Materials," by **F. P. Zimmerli**, Barnes-Gibson-Raymond Division, Associated Spring Corp.; "Corrosion Resistant Metals for Valves and Seats on Heavy-Duty Engines," by **A. T. Colwell**, Thompson Products, Inc., and "Seating and Other Aspects of the Driver's Environment," by **A. E. Neyhart** and **C. G. Seashore**, Pennsylvania State College . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

VEHICLE engineering know-how seasoned with the proper metallurgical ingredients will evolve recipes for truck and bus improvements looked for by operators, engineers attending Truck and Bus and Materials sessions were told.

For example, a leading engineering executive showed that marriage of modern metallurgy and sound engineering can give birth to an exhaust valve and seat-insert design to cope with any known heavy-duty vehicle operation today.

He advised designers that some engines like one steel better than another. This may be a function of factors such as block design, cooling, cam design, spring pressures, and operating temperatures. But engine design can enhance or detract from valve performance. A sweeping port with a high boss improves exhaust valve operation. And the larger the guide clearance, the hotter the valve head.

This engineer predicted universal use of a hardened seat insert in the near future. The next step – sodium-cooled valves – is now under way. He also foresaw wide use of positive rotating valves for extended valve life.

Yesterday's hopes plus today's technology will produce tomorrow's practical steam powerplant for motor vehicles, a consulting engineer promised. He contended that modern materials coupled with greater knowledge of fluid flow and combustion have, or can with further research, eliminate steamer obstacles that forced their abandonment years ago.

Steam engines appear particularly well-suited to commercial vehicles, exhibiting characteristics similar to diesel engines. Frequent shifting and steep-grade operation are naturals for steam engine applications.

Basic advantages of vapor power generation and minimization of disadvantages prevalent in the "Steam Is Supreme" days merit consideration of practical possibilities, it was urged.

Unlike internal combustion engines, the vapor system's functions of energy release and conversion to power are separate. The steam engine provides high stall and starting torque. Expansion ratios can be as high as 80 and 100 to 1. Since the vapor engine delivers higher outputs per unit displacement, engines can be one-half to one-third the size of equivalent internal combustion powerplants. Efficiencies are high and engine design is simple, with fewer parts.

Vast simplification, and possible elimination of clutch and transmission and exclusion of carburetion should make steam engines less costly than present-day engines. The old bugaboos of the steamer – long starting warm-up, cold weather freezing of fluid, and frequent watering-up – can be cut to minor proportions.

Slide Rule and Materials

Importance of blending the slide rule and materials functions manifested itself in a discussion of spring manufacture. Here the right metal, properly fabricated, constitutes the successful product – whether it's an engine valve spring, coil spring, or suspension leaf spring.

One spring specialist advocated use of hardened material as best practice before fabricating the spring. His reasons are threefold.

First, it eliminates practically all possibility of hardening cracks in the finished product and locates existing laps or seams during fabrication. Second, nonuniform material temper will show up in uneven recoil from forming tools, easily detecting nonhomogeneous materials. Third, it lengthens fatigue life. This is especially important in valve springs.

Steel for automotive coil springs is usually hot rolled. The rods are then cold drawn to remove surface flaws. Surface condition – rather than hardness or chemistry – is the controlling factor. Use of alloy steel here is justified only if increased hardenability and slightly higher elastic limit achieve some cost saving.

Hot-formed steels for front-wheel suspension leaf springs were said to be given the endurance of mechanical springs with shot peening and surface grinding.

The vehicle industry's contribution to off-the-

road operations of construction industry equipment proved provocative in the light of the anticipated boom in construction of airports, superhighways, dams, and railroad right-of-way replacement.

Extensive discussion from the floor evidenced vehicle-building activity toward improving earth-moving behemoths. A diesel engineer emphasized the need for four-speed transmissions to eliminate horsepower losses. A tire and rim expert showed how recently-developed demountable rims can save valuable time when tire-removal delays can make failures costly.

Light was thrown on the invitation to heavy vehicle punishment and short life by neglecting springing. A clutch technician warned vehicle builders and operators to consider the clutch expendable, and not a "dry torque converter."

Hauling rock, earth, concrete, and coal payloads over rocky and muddy terrain demands a rugged vehicle that's mechanically simple and cheap to operate. Dump hauling units must be fast on the haul road, fast in discharging, and relatively light in weight.

Two safety experts decried the short-range thinking of commercial vehicle builders in refining equipment for longer life and increased efficiency without considering the driver. They felt that neglect of the driver's comfort is penny wise and pound foolish. Driver fatigue and discomfort will be taken out on the equipment, consciously or unconsciously.

Poor visibility, lack of proper heating and ventilating, high noise levels, poor lighting, and other items were said to be accident-inducing factors.

Seating comfort came in for particular emphasis. These experts considered lack of it in present commercial vehicles the number one cause of fatigue. Extensive plans were described for a nation-wide survey of 500 truck drivers to find body measurements and space requirements around which the seat and entire cab should be designed for maximum driving comfort. Lack of funds has temporarily stymied this project.

DIESEL

Design Innovations Proposed, Cylinder Wear Factors Exposed

Based on seven papers, and discussions, presented at two Diesel Engine sessions under chairmanship of **W. G. Ainsley** and **L. C. Lichty** . . . Symposium on Cylinder Wear: "Piston Rings," by **K. H. Effman**, Perfect Circle Corp.; "Engine Operation," by **L. A. Blanc**, Caterpillar Tractor Co.; "Lubricating Oil," by **B. M. Berry**, California Research Corp.; "Fuel," by **A. J. Blackwood**, Standard Oil Development Co.; and "Instrumentation," by **N. C. Penfold**, Armour Research Foundation . . . Symposium on Unusual Engines: "Fuel Injection Engine with Spark Ignition," by **A. M. Starr**, and "Slant Mechanism – Its Fundamentals and Application to Diesels for Aircraft and Other Low Weight Fields," by **T. L. Sherman**, Steel Products Engineering Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

DIAGNOSIS of cylinder wear in conventional diesel engines yielding several remedies and freedom from other chronic diesel shortcomings claimed for two unorthodox powerplants, shared the spotlight in two interest-packed sessions.

Improvements in engine design, metallurgy, operating practice, fuels, and lubricants have brought cylinder wear to a very low rate in present-day engines, symposium speakers brought out. Wear, nevertheless, still appears to be the limiting factor influencing the time between overhauls.

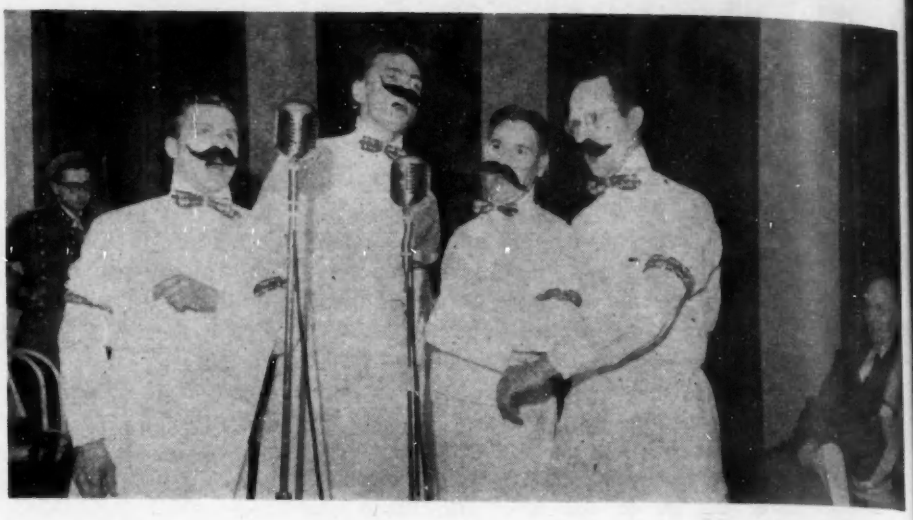
Cylinder wear is of three kinds – abrasive, corrosive, and a violent type called scuffing. Low abrasive wear was reported to call for rings of greatest width, whereas lowest scuff resistance results with narrow rings.

To reduce ring, and therefore cylinder wear, it is said that surface hardening of a special cast iron, fully hardened alloy cast iron, or chrome plating of the face of the rings is helpful.

Protection from scuffing, it was pointed out, can be effected by interrupting the ring faces with narrow grooves, filled with some other material to prevent excessive oil consumption. Clean intake air, chrome plating, and a break-in coating also help to prevent this condition, according to one speaker.

He analyzed one operator's trouble with burnished rings as flutter . . . a trouble common with insufficient side clearance or improper ring thickness. Speed is essential in correcting this condition because flutter is an omen of broken rings and piston failure to come.

Engine operating conditions were said to affect abrasive material entering the cylinders. It was



AT GAY NINETIES PARTY on Sunday evening Furber Marshall was a masterful and magnificent master of ceremonies – and the Western Michigan Section quartette pictured here won the barber shop singing contest. Quartette members are: Don Richards, Harold Lobb, Laverne Kibbey, and Dick Hendricks. Over in the right hand corner is Dick Grant, famed chorus and song leader, who lead some lusty mass singing

stressed that good air cleaner and filter maintenance, and good drain period practice are essential.

Corrosive wear, however, is said to increase with light loads and low-temperature operation. It was also reported to be influenced by fuel composition and the condition of the lubricating oil, although these effects seem to be hard to measure.

Clue to Corrosion

A European engineer found a clue to corrosion causes in a series of tests his company ran. An engine, run continuously, exhibited considerably less corrosion than one run the same length of time, but stopped periodically and then started up again. Apparently engine starting induces an acetic condition, accelerating corrosive wear.

In general, it can be said that the type of oil used has an appreciable effect on engine wear under scuffing conditions and in operations that involve either high or low-temperature corrosion. Abrasive wear is not believed to be influenced to any measurable degree by lubricating oil properties.

In small high-speed engines, high sulfur content, high viscosity, and poor volatility of fuel tend to induce wear.

Tests indicate that sulfur is burned to sulfur trioxide, which can affect wear because:

- It is corrosive in itself, or
- It seems to break down the lubricating oil so that a hard, abrasive carbon is formed, or
- The carbon may deposit in the ring grooves, increasing metallic friction.

Effects of viscosity and volatility are still little understood, and it was stressed that much research must be done to find the extent and exact nature of their influence.

Cetane number generally does not play an important part in cylinder and ring wear. But ignition quality below engine requirements usually increases fouling, which may eventually accelerate engine wear.

Discussion brought out proper combustion through the right kind of turbulence as the cure to most diesel ills, including some wear. Air should be introduced hot and from the proper direction; it should not chill the fuel and delay combustion. Taking steps along these lines was said to eliminate local over-richness and its attendant problems.

Measurement of cylinder wear is complicated by many factors. Instruments that may be satisfactory in manufacturing and inspection, it was pointed out, may be too expensive, too limited in flexibility, or too cumbersome to be applicable in engine rebuilding; they may be insufficiently accurate or too limited in application to be valuable research tools.

As a result, many types of instruments have been devised, each one being satisfactory under certain conditions.

For example, measuring a diamond-tool indentation before and after wear has the advantage of disclosing metal removed from the wall rather than diametral change, as with dial indicators. Accuracies of 0.00002 in. are claimed for this technique, with smaller amounts of wear detectable. But calculations involved are rather complicated.

Chemical analysis of oil drippings from the cylinder is a speedy method of finding how much metal has been removed, but supplementary measurements are needed to find where the wear took place.

Barrel Engine

Portion of the program devoted to diesel development brought forth an opposed-piston engine of the barrel family, in which a slant mechanism converts reciprocating piston motion to rotating mainshaft motion.

Mechanical efficiency of this engine, its designer said, is easily comparable with that of conventional types. Friction of 20 main bearings in comparative crankshaft engines is greater than that from the two lightly-loaded bearings in the slant engine.

Also claimed for this arrangement are extreme compactness and low weight; absence of cylinder heads; optimum timing without operating valves; minimum cooling surface around combustion space so that less heat is removed by the coolant; increased dimensions of combustion space, simplifying injection; uniflow exhaust, scavenging and charging; maximum port area; and control of air motion within the cylinder, which aids the combustion process.

Second unusual powerplant was a fuel-injection engine in which spark ignition is substituted for the compression ignition, operation being at compression of 7 to 10 to 1. Easier starting, greater speed range, lighter weight, adaptability to small engines, and insensitivity to different fuels are claimed.

Biggest development headache appears to have been inability to obtain reliable ignition throughout all loads and speeds of operation – due to the narrow range of ratios over which a spark can ignite a fuel-air mixture.

Part-load operation was attained, however, by cutting out half the cylinders when the load dropped to 25%. The remaining cylinders are fed sufficient fuel to carry the load.

When cold, the engine needs gasoline for priming; but no warmup period is required as the engine is said to run steadily immediately, regardless of temperature.

T & M Engineers Told of Dynamometer Use and Hear Design Suggestions for Air Brakes

IMPROVED operating economy and safety high-lighted the two Transportation and Maintenance Sessions. A detailed study of chassis dynamometer use and a comprehensive analysis of air brake design showed the need for even more exchange of technical data and experience in those phases of fleet operation engineering.

Based on discussions and two papers presented at two sessions on Transportation and Maintenance, under chairmanship of **J. R. North** and **E. P. Cohn** . . . "Utilization of Chassis Dynamometers and Maintenance Record Analysis to Improve Operating Economy" by **E. J. Gay** and **H. T. Mueller**, Ethyl Corp., and "Air Brake Designing to Reduce Failures and Speed Up Action," by **Julius Gaussoin**, Silver Eagle Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

The test work with the chassis dynamometer was made with the cooperation of the St. Louis Public Service Co., where for 24 consecutive months 41 coaches were used.

Although the level of maintenance of that fleet is typical of the highest in the country, fuel economy of from 8 to 10% was achieved, average number of driver complaints was reduced up to 15%, and the average reduction of road calls was about 20% on a per unit basis. The fuel economy represented a yearly saving of from $125 to $150 per coach.

It was clearly shown that adequate carburetor maintenance is the greatest single factor effecting fuel economy, but the competency of shop and supervisory personnel; and quality, completeness and analysis of maintenance records are important to achieve overall operating economy.

Byproduct of the program was the disclosure of numerous findings of interest to vehicle designers, although the work was done primarily to determine the value of this test equipment in fleet repair shops. For example, it was found that carburetors should be cleaned after 20,000 miles. Because of inaccessibility of the carburetor on most engines, operators are loath to remove this unit unless forced by other reasons to do so.

A load-time recorder determined totals of operating, idling, coasting, part load and full load time. Because idling and coasting time was in excess of 50% of the operating time, a dependable device to stop flow of fuel at such times was suggested to increase gasoline savings.

Checks taken during February and March, 1945, showed that 35.5% of total engine operating time is spent in idling while parked outdoors, costing from 140 to 210 gallons of fuel per coach per month. This practice is also costly in engine wear, and in sludge and varnish formation.

Inaccessibility of flywheel markings adds to the cost of maintenance, and in general the test program substantiated the conclusions of Templin, Nail, Laurie, Bixby, Werner, Patras, Preble and others in SAE papers on the inaccessibility of components on motor vehicles. Protractors in 1 deg increments at 120 deg intervals would permit distributor advance characteristic to be checked while the engine is in the vehicle.

Attention of engine designers was called specifi-

cally to the difficulty of removing valve covers, carburetors, fuel pumps, ignition wiring, spark-plug, and fan belts. There appears to be overwhelming evidence that increased accessibility would reduce the rising cost of vehicle maintenance.

Based on a series of tests of truck-trailer combinations of 72,000 lb each in three freight fleets, a group of Pacific Coast operators concluded that air brake designers might keep these factors in mind:

Lag is increased by large brake chambers, front wheel brakes, quick release valves, T's, elbows, and other restrictions.

Lag would be reduced by larger relay-emergency valves, and one relay-emergency valve for each pair of brake chambers.

Relay valve action would be speeded by short foot, large throw valve and trailer brakes would be speeded by industrial air couplers, with a minimum of fittings on jumper house to trailer.

Chamber size and lever length should be adjusted so that tires leave a minimum of rubber on the pavement, but brakes must not lock. Slow, or low, air pressures to the brake chambers must be remedied. The operators also agreed that a close range between the minimum and maximum air-governor settings is extremely desirable.

Plane Engine-eers Explore Fuels for JETS, ROCKETS

Based on four papers presented at two Aircraft Powerplant sessions under chairmanship of **F. W. Godsey** and **F. C. Mock** . . . "Preliminary Performance Analysis of Gas Turbine Powerplants for Aircraft," by **I. H. Driggs**, Bureau of Aeronautics, Navy Department; "An Analysis of Composite-Powered Aircraft," by **B. T. Salmon**, Ryan Aeronautical Corp.; "Flame Propagation Rates at Reduced Pressures," by **W. C. Johnston**, Westinghouse Electric Co.; and "Fuels for Rocket and Jet Powerplants," by **E. L. Klein**, Bureau of Aeronautics, Navy Department. All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions

STAR billing in the Aircraft Powerplant Sessions went to the gas turbine, with reciprocating engines and rockets definitely playing the minor roles.

Military requirements were highlighted by talk of researching for satisfactory fuels for jets and rockets; of how to estimate turbojet and turboprop performance by a new system of preliminary analysis. Composite-powered aircraft were also discussed.

Jet and rocket engineers were apprised of basic concepts in fuel combustion. Studies of how fast various fuels burn showed that flame propagation rate is important because it determines flame length in the combustor and maximum flow speed before blow-out.

One researcher found flame propagation to be dependent on two factors: (1) condition of flow within the combustor and (2) normal combustion speed of the fuel – a function of the physical properties of the fuel and oxidant. His investigations to date with natural gas, gasoline, and acetylene partially explain flame behavior. For example, both flame velocity and the region of stable burning increase with inlet temperature. And the burning region diminishes with lower pressure.

While normal combustion velocity was found to depend on mixture composition, temperature, and pressure, more experimental data on different fuels must be obtained to understand more fully the combustion process.

Engineering of fuels to get proper flame propagation points up Navy realization that wartime requirements for jet powerplants to run on standard aviation fuel were unnecessary – that the high performance numbers and lead content of such fuels perhaps were even detrimental. Current work, a Navy speaker said, aims at a specification which balances availability, safety, and handling requirements with engine operating needs. One simplification already found is that varying the fuel's volatility and chemical composition affects combustion efficiency little, provided the combustor design is good.

Rocket fuels, military research finds, present special problems. A practical propellant should be safe to store and handle, give a maximum specific impulse with maximum density, be readily available, and reasonably cheap. But no one oxidizer and propellant combination meets all these requirements.

For example, it was said that the explosive and corrosive character of high energy fuels such as anhydrous hydrazine makes them ticklish to handle. And liquid-hydrogen liquid-oxygen systems offer high specific volume; but the low density of liquid hydrogen – 4.4 lb per cu ft – requires a large fuel volume capacity.

Concluded on page 97

More Efficient Utilization of Fuels

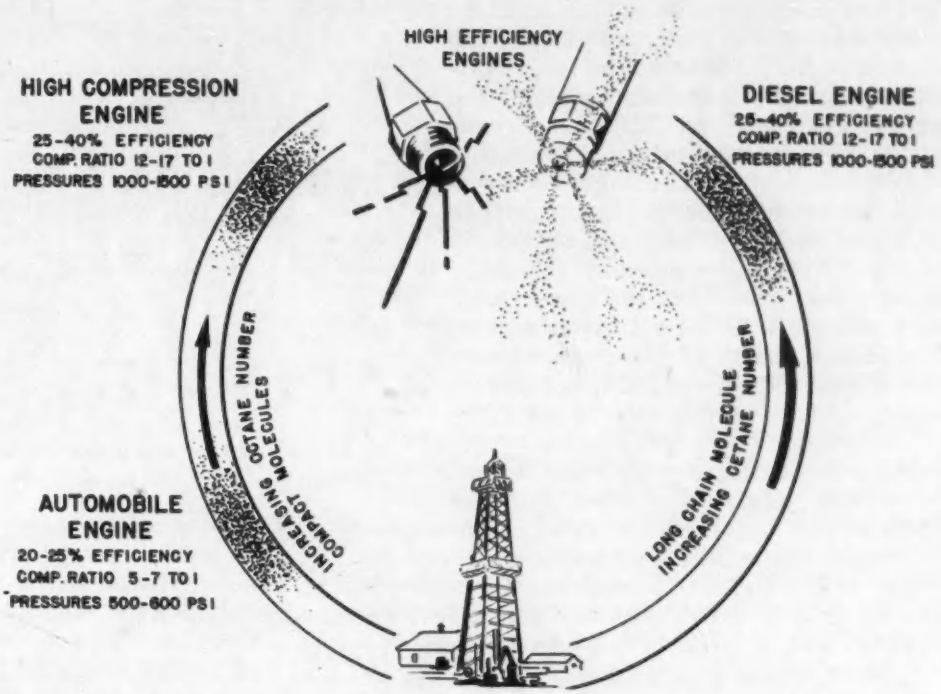


Fig. 1 – The engine efficiency circle demonstrates that a barrel of crude can be refined by either the diesel or gasoline routes. The higher the gasoline octane number and engine compression ratio, the more nearly do thermal efficiencies approach those of diesel engines

EXCERPTS FROM PAPER* BY **Charles F. Kettering** GENERAL MOTORS CORP.

(This paper will be published in full in SAE Quarterly Transactions)

THIRTY years of research gave birth to a 12.5 compression ratio engine of conventional design that delivers 35 to 40% more mpg on 99/87 octane fuels, producible by existing refining processes.

The key to higher efficiencies in internal combustion engines is in the increase of the compression ratio. In times past, attempts to utilize this important principle in spark-ignition engines have run into fuel knock. It is well known that the large gains in efficiency made by the diesel engine are due mainly to increasing the compression ratio. To obtain the better high efficiencies from high compression ratios there have been two approaches. Fig. 1 shows the story.

Crude oil as nature gives it to us can be refined and processed to make either diesel fuel or gasoline. In making diesel fuel, the right-hand path is taken on the diagram to obtain the characteristics essential for this type of engine. In making gasoline, the left-hand path around the diagram is taken to obtain as high octane number as possible. In both cases the end result is a high-compression engine giving high thermal efficiencies.

At present diesel engines are operating with a range of compression ratios between 14 and 17 to 1, and with brake thermal efficiencies as high as 38%. If equivalent compression ratios can be used in spark-ignition engines, the same full-throttle brake thermal efficiencies should be obtained. The reason automobile engines are in the range shown on the chart of about 6½ to 1 compression ratio with a maximum of about 25% thermal efficiency is because engines and fuels have not yet been adequately matched.

The knocking characteristics of a fuel are related to the molecular structure in a very definite

*Paper "More Efficient Utilization of Fuels," was presented at SAE Summer Meeting, French Lick Springs, June 4, 1947.

order. It was the discovery of this property of hydrocarbons which expedited the development of high octane fuels.

6-Cyl High Compression Engine

Tests on a high-compression single-cylinder engine plus diesel experience gave the basic data for designing and building a 6-cyl engine which could be installed in a car. The compression ratio chosen was 12.5 because the single cylinder data had shown that most of the gains in efficiency on this cylinder construction could be obtained at this ratio.

Displacement of the high compression engine was selected in accordance with the single cylinder test so that it would deliver approximately the same horsepower throughout the speed range as a standard 1946 production engine. It was also designed to be readily interchangeable with the standard engine so that it could be installed in the car without difficulty.

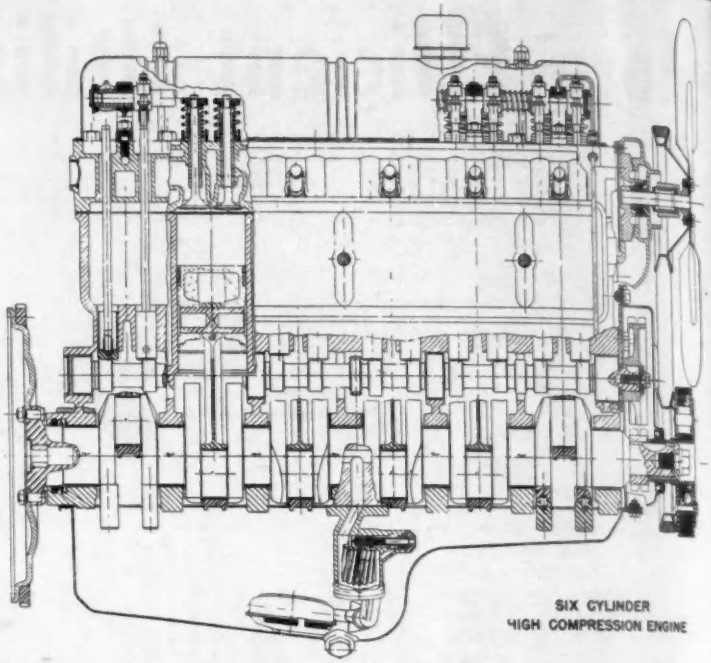


Fig. 2 – Cross-sectional views of the 12.5 compression ratio engine

With approximately the same horsepower, the same axle ratio, and the same weight, the two cars should have equal performance. No weight limitation was placed on the design of the high-compression engine. The object was to provide a mechanically sound test engine in which weight could be considered later.

Table 1 shows a comparison of the high-compression and 1946 stock production engines as to specifications and performance factors. While it was planned to use triptane as fuel for the early work on the 6-cyl engine, a compression ratio high enough to require triptane was not used.

The ratio was chosen to obtain the greatest practical part of the gains of high compression ratio as indicated by the single cylinder tests. If we had been building a triptane engine, the ratio would have been considerably higher – probably 15 or 16 to 1.

The engine was designed according to rather conventional procedures, except that it was made rigid enough to carry the higher loads imposed. Our wide diesel experience helped greatly on this problem because the stresses involved are comparable. After we found that there were no special difficulties from roughness and high friction on the first experimental engine, we made a second experimental design which follows conventional practice.

Fig. 2 shows cross-sectional views of this experimental design. This new engine was designed from our experience in the high-compression project on both the single and original 6-cyl engine and weighs no more per horsepower than stock engines.

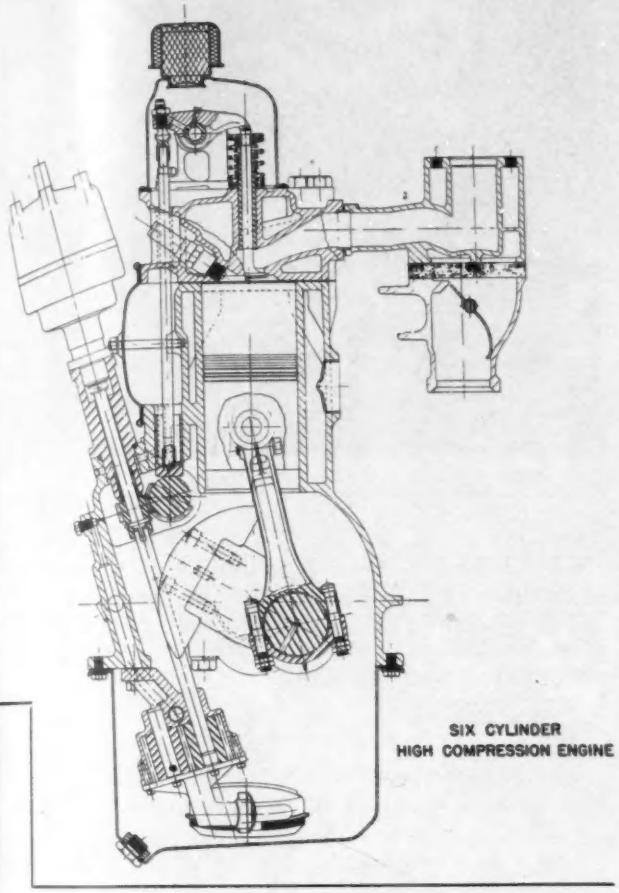
The horsepower of these two engines was comparable. The brake mean effective pressure is, of course, very much higher on the high compression engine at all speeds for it is only 181 cu in. displacement compared with 238 cu in. on the stock engine. Volumetric efficiency of the high compression engine is as good or better than the stock engine at all speeds, showing that there is no restriction to engine breathing.

The large gains in brake mean effective pressure are a measure of the gains in specific output. The stock engine has a maximum bmep of 109 psi at 1250 rpm and the high compression engine a maximum bmep of 130 psi at 1750 rpm. These tests were made in the "as installed" condition with muffler, tail pipe and all accessories and corrected for barometer, temperature and humidity according to our own engine test code.

Fig. 3 shows further comparisons of the full throttle performance of the two engines. Friction mean effective pressure and mechanical efficiency are both improved on the high compression engine.

Table 1 – Comparison of High-Compression and Production Engines

	12.5 Compression Ratio Engine	1946 Engine
Number of Cylinders	6	6
Valve Arrangement	Overhead	L-Head
Bore and Stroke	3⅜ x 3⅜	3½ x 4⅛
Displacement – cu in.	181	238
Compression Ratio	12.5	6.4
Compression Pressure at 2000 rpm	420 psi	165 psi
Peak Pressure at 2000 rpm	1150 psi	525 psi
Engine Torque at 2000 rpm	154	163
Mechanical Efficiency at 2000 rpm	85%	81.5%
Maximum bhp	95 at 3600 rpm	85 at 3400 rpm
Minimum Brake Specific Fuel	0.40 at 2000 rpm	0.54 at 2000 rpm
Mpg at 40 mph	26.5	18.5
Heat Rejection to Water in Btu per bhp per min	31.5	45.5
Rear Axle Ratio	3.63	3.63
Car Test Weight in lb	4110	4110



SIX CYLINDER
HIGH COMPRESSION ENGINE

These values show that it is possible to design a high compression engine without excessive friction, a fact which bears out diesel experience.

The brake specific fuel curves indicate the full throttle gains between the stock 6.4 to 1 compression ratio engine and the 12.5 high-compression engine. We obtained a minimum specific fuel consumption of less than 0.40 lb of fuel per bhp-hr in comparison with 0.54 for the stock engine. This is a gain of about 35%, which checks very well with the single-cylinder data tests.

It is also comparative with full-throttle diesel fuel consumption, showing that, at equivalent high compression ratios, it makes little difference whether there is compression ignition or spark ignition. Both types of engine give high full-load fuel economies.

Throughout the speed range, the high-compression engine loses less heat per horsepower through the exhaust and cooling water, and more is utilized in producing power. Heat rejection for the high compression engine is almost 30% lower than for the stock production engine.

Curves in Fig. 4 show the relation between miles per gallon and per cent load at 2000 rpm or, in this case, 40 mph. They illustrate a very important characteristic of the economy gains resulting from higher compression ratio. The gains are consistently large throughout the entire load range. Similar dynamometer data taken at other speeds show the same tendency to maintain the economy gains at all throttle positions.

Road Testing the 6-Cyl Car

It is difficult to predict from dynamometer tests how an engine will react under the widely varying requirements of car operation. Roughness, general performance, driving economy, flexibility, and other factors can only be determined in a car on the road. An engine in a car is the final proof.

The 6-cyl high-compression engine was installed in one of two of the same model stock automobiles, both equipped with Hydra-Matic transmissions. Fig. 5 shows the high-compression engine installed in a car. These two cars, the one with the standard engine and the one with the high-compression engine, have been run on comparative road tests for many months.

Both the car with the standard engine and the high-compression engine give normal, smooth operation. A short drive shows that the performance and feel are just about the same as a production car, and it is impossible to tell from driving the two cars which one is which, except at high speeds where the high-compression car is somewhat faster. It should be remembered that the output of the high-compression engine was made to match the same performance as the standard engine. The factor that cannot be demonstrated on a short run in the car is the greatly increased economy.

Fig. 6 shows a comparison of constant speed level road economy of the high compression and

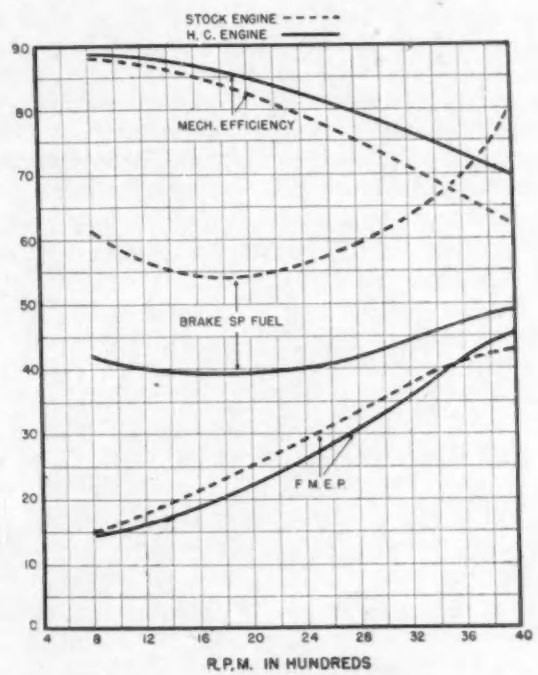


Fig. 3 – Comparative performance curves of the standard and high-compression engines

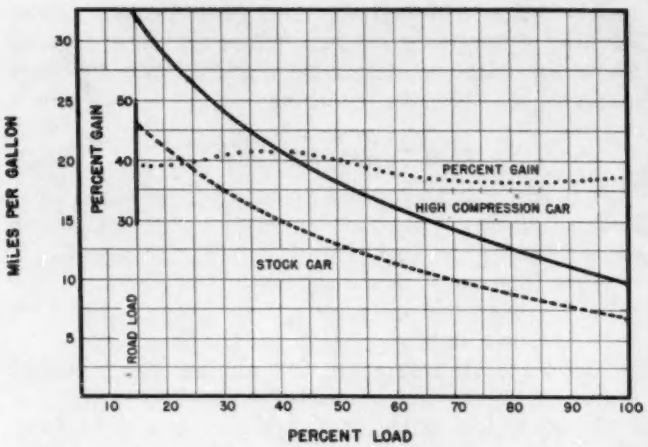


Fig. 4 – Shown here is the gain in fuel economy of the high-compression car over one with the standard engine over the load range, at 40 mph

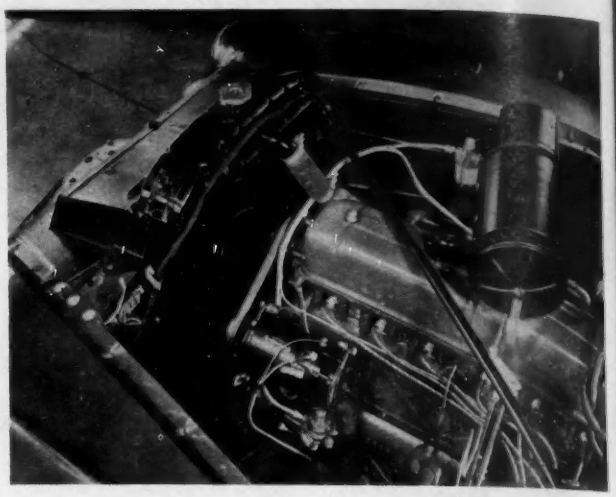


Fig. 5 – The high-compression engine in a 1946 production Oldsmobile

standard cars. These data show that, under these conditions, the high compression car gives from 35 to 40% better economy in miles per gallon than the standard car. At 40 mph the standard car has a fuel economy of 18.5 mpg, while the 12.5 compression ratio car has an economy of 26.5 mpg – an improvement of approximately 40%. At 60 mph the saving is 35%.

While these data are important from an engineering standpoint, they give only part of the story because automobiles are not driven on level roads at constant speed very much of the time. Approximately two-thirds of the gasoline is consumed in city driving, where a large percentage of the operation is transient and requires the entire throttle range of the engine.

Dynamometer tests indicated that the high-compression engine should show about the same gain in economy over the standard car, regardless of load or driving condition. To determine the actual gain in economy a number of cross-country trips were made where both cars were driven together under the same speed and traffic conditions.

On a large number of such trips under widely varying road conditions, the average gain in economy was about 33%. Where the maximum speed was held below 50 mph, the gain was 35%. In the same test made with the maximum speed limited to 70 mph, the gain was 33%.

Several extended trips made entirely in city traffic show gains of over 40%, which is of major importance in view of the large quantity of fuel burned under these conditions.

Many of the preconceived troubles which were expected failed to materialize after the engine was running. Engine roughness was eliminated by proper structural design. With some modification of the ignition coil winding and core material, conventional 6-v ignition has proven adequate on this engine. Cold starting has not been a problem at temperatures encountered in the Detroit area during the past winter. It was thought that the effect of combustion chamber deposits might become critical at high compression ratios. Almost 10,000 miles of driving with a leaded fuel has failed so far to develop any trouble.

Engine Fuel Needs

The maximum antiknock requirement was approximately equal to iso-octane plus 0.9 ml tetraethyl lead per gal.

Fig. 7 is a representation of the performance of three widely different types of fuel which may be of interest. Diisobutylene is an extremely sensitive fuel – as indicated by its Research octane number, equivalent to iso-octane plus 0.5 ml of tetraethyl lead, and ASTM octane number of 88.

Iso-octane is a fuel of zero sensitivity by definition, since it is the primary reference fuel. The

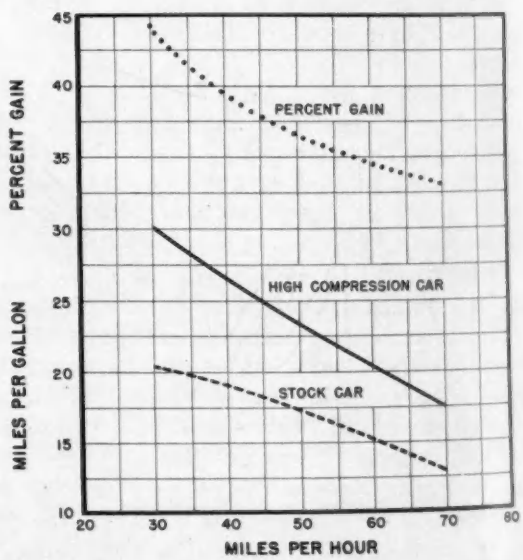


Fig. 6 – Constant-speed level-road economy of the high-compression car compared with that of the standard car

experimental test fuel was a sensitive type of gasoline which was produced by catalytic cracking and, with 1.5 ml of tetraethyl lead, had a Research octane number of 99, and an ASTM octane number of 85. It is understood that such a fuel could be made and sold in large quantities at a comparatively small premium.

Fig. 7 illustrates several very significant things about the performance of these three fuels in this engine.

1. That it is possible to operate this 12.5 compression engine with 99/87 octane number gasoline, although with some slight detonation at speeds above 55 mph.

2. That, with comparatively small changes in spark advance, an engine of this type can be operated satisfactorily over the entire speed range with a fuel of approximately 99/87 octane number.

3. The relatively high ratings of diisobutylene and of the experimental test fuel with respect to iso-octane are better than would be expected from an interpretation of the Research and ASTM octane numbers.

Chemical and Mechanical Octane Numbers

For the following discussion we might think of the problem of operation of high-compression engines as made up of two kinds of octane numbers: first, are what we might term "chemical" octane numbers; and second, "mechanical" octane numbers.

The "chemical" octane numbers are built into the fuel by refining methods and by the addition

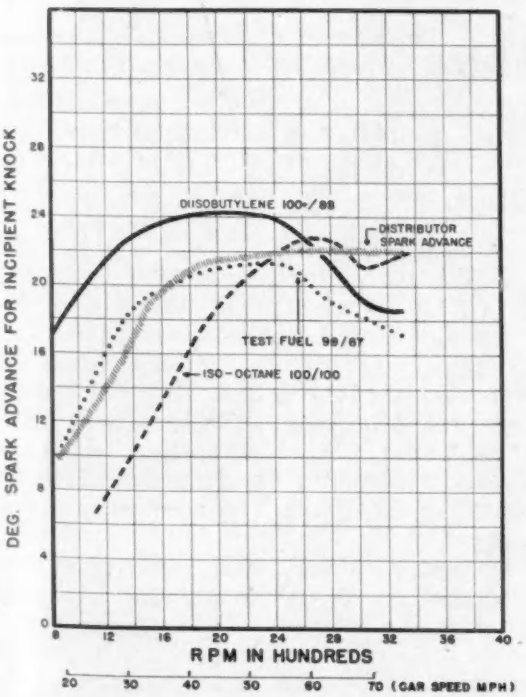


Fig. 7 – Knock characteristics of three different fuels in the 12.5 compression ratio engine

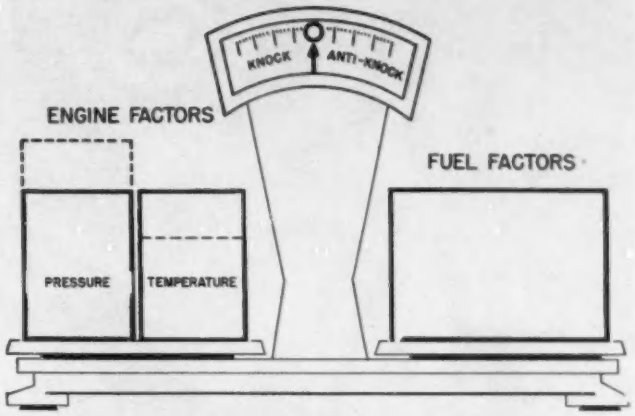


Fig. 8 – Any balanced engine design is a compromise between "mechanical" and "chemical" octane numbers. "Mechanical" octane number is largely a function of temperature and pressure relationships. If engine temperature factors are reduced, higher pressures – compression ratio – can be allowed to balance the given fuel factors

of tetraethyl lead. We pay for these octane numbers when we buy the gasoline at the filling station; responsibility for supplying these "chemical" octane numbers rests with the petroleum industry.

"Mechanical" octane numbers are what the engine designer builds into the engine, and they are delivered to the customer when he buys the car. Factors which influence "mechanical" octane numbers are compression ratio, spark timing, piston temperature, valve temperature, mixture temperature, mixture ratio, valve timing, and combustion chamber shape.

The idea of "mechanical" octane numbers is not new, as much work has been done in the last 30 years on combustion chamber design, and many other fundamental engine factors. In addition, when an engine is installed in an automobile, transmission characteristics become an important factor that affects octane number requirements.

In this 6-cyl, 12.5 compression engine the "mechanical" octane numbers have been developed to a high degree although it is believed that considerable improvement in octane requirements of engine at any compression ratio can be accomplished by attention to these factors mentioned above. At the same time, these gains in octane number requirements are frequently accompanied by increases in power.

Temperature and pressure are the two important factors which affect knock, and the control of "mechanical" octane numbers is largely a problem of control of the temperature and pressure relationships of the charge at the time of ignition.

Fig. 8 illustrates the problem involved. The fuel factors must be balanced against the engine factors to obtain efficient nonknocking combustion. The fuel factors which make for high octane number are the methods of refining – such as thermal cracking, catalytic cracking, alkylation, polymerization, and reforming. Additions of tetraethyl lead

concluded on page 64

Birth of

SPECIFICATIONS laid down to the Bonanza designers called for an airline-type performance airplane capable of carrying four normal-size people with reasonable comfort. They also detailed such items as adequate instrumentation and night flying equipment for flight in any reasonable weather; enough fuel for flights of practical duration; and baggage space consistent with travel needs of the average individual.

Layouts of the design incorporating the features and objective discussed were made. The stylist carried on his work simultaneously – especially on the interior – to insure pleasing, attractive and comfortable quarters for the occupants. In the initial stages of design, there was no specific powerplant available which we considered satisfactory for our application.

Lycoming and Continental were contacted to see if they would be interested in supplying powerplants to meet specific requirements. Market analysis indicated that demand would justify the development of an engine for this general application. An engine of 150 hp minimum was considered the lowest power which would be acceptable.

Preliminary performance estimates prior to the wind tunnel tests indicated that a sea level high speed of 160 mph should be attainable. Calculations made on the basis of the wind tunnel tests indicated that a sea level speed of 165 mph or slightly more could be realized. These figures made the possibilities of the airplane look quite promising. The other performances computed from the wind tunnel tests were equally encouraging.

Several desirable minor modifications in the aerodynamics of the airplane were found advisable. The model was tested with both a laminar-flow airfoil wing and the NACA 23000 airfoil series wing. The tests definitely showed that the conventional 23000 series wing was superior in practically all respects to the laminar-flow wing. This established the wing to be used on the production airplane.

Development of "Butterfly" Tail

During the war, the company found that the control characteristics of the "V" tail could be made perfectly normal and that there were definite weight and cost savings with improvement in performance. These considerations led to a study of the "V" tail application on the Bonanza.

Control action of the "V" tail is as follows:

Elevator action for longitudinal control is by deflecting the elevators about their axes in the normal fashion. For reasonable elevator deflections, the force increments on the tail surfaces are roughly proportional to the angular displacement. Since the airforce is normal to the surfaces (viewed in front elevation), the side component forces balance out due to symmetry. The resultant force change is strictly normal with the conventional tail arrangement.

If we desire rudder action, we displace the surfaces oppositely about the elevator trim position existing at the moment. Since the normal force is nearly proportional to the elevator displacement, the vertical force will remain unchanged if the downward deflection of the one is equal to the upward deflection of the other.

of the Beech Bonanza

EXCERPTS FROM A PAPER* BY

HERB RAWDON

Assistant Chief Engineer, Beech Aircraft Corp.

Since the loads are now unsymmetrical on the two halves, there is a resultant side component which causes the tail to be displaced side-wise and the airplane to yaw.

Actually, there is no particular advantage of the "V" tail in control or stability over the conventional arrangement; but in the present case a weight saving of 20 lb and a cost saving of $100 were realized by using the unconventional arrangement. Further, an increase in high speed of 3 mph was accomplished. In view of our success with the "V" tail, it is planned that future Beech models will feature this tail arrangement.

Landing Gear Selection

Much discussion in the preliminary layouts centered around the type of landing gear which would be used. These discussions considered whether the gear would be of fixed or retractable conventional tail wheel or tricycle gear arrangement.

Argument on the conventional fixed wheel gear was that – if properly designed aerodynamically – the drag would not be excessive and the performance of the airplane would not be affected appreciably. Further, being the simplest arrangement, it would give the most reliable service in the hands of the pilot of limited experience and would be the least expensive to produce. The conventional tail wheel gear also has better ability than the nose wheel gear to get out of smaller places with runway surface conditions of poorer quality.

The nose wheel or tricycle gear design is much nicer in its taxiing and ground handling characteristics. Its take-off and landing characteristics are entirely satisfactory for surface runway conditions that exist on any reasonably qualified permanent airport.

Reviewing all these arguments and recognizing that it would be the most expensive to build, it was decided that we were working for attainment of the best possible performance and handling characteristics. So a fully retractable tricycle landing gear was decided upon.

Powering the Bonanza

It was obvious at the start that a radial type of engine was impossible for the type of airplane being considered. With the radial engine, vision would be unsatisfactory and it would not be possible to get a sufficiently large propeller diameter for best performance due to limited ground clearance. A high thrust line and low cowl line were obviously necessary. This left the engine choice to the flat or inverted type, and obviously the engine must be aircooled.

Having made this choice on landing gear type, further restriction was imposed on engine selection. It appeared virtually impossible to use an inverted engine, and have sufficient space to retract the nose wheel. A typical "flat-engine" would be required and, incidentally, was the type being developed by both Lycoming and Continental.

Most small and popular-priced aircraft had, in

BONANZA PERFORMANCE

Top speed at sea level	184 mph
Recommended cruising speed (at 115 hp)	175 mph at 10,000 ft
Rate of climb at sea level	950 fpm
Service ceiling	15,600 ft
Take-off run, sea level, 10-mph wind	490 ft
Landing run, sea level, 10-mph wind	365 ft
Stalling speed, sea level, with 20-deg flaps	53 mph
Stalling speed, sea level, without flaps	62 mph
Maximum range at 165 mph at 10,000 ft	790 miles
Fuel economy, depending on speed and altitude, varies from	14.5 to 18.8 mpg

*Paper "Development of the Beech Bonanza Light Four-Place High Performance Airplane," was presented at SAE Mid-Continent Section, Ponca City, Dec. 6, 1946.

the past, suffered considerable performance penalty because of the excessive propeller rpm at which the engine was rated. These high propeller speeds were of course an attempt to get the maximum engine powers with the minimum engine size, weight, and cost.

Recognizing the importance of the slow turning propeller, the Beech company imposed restriction on the powerplants for the Bonanza where rpm's between 1925 and 2050 would be acceptable. This compared to current practice of using 2550 to 2600 as rated propeller rpm for engines then available.

Actually there was little to choose between these engines. The Continental engine was a few pounds lighter, but it occupied more space and was penalized by a more complicated exhaust manifold. Some skepticism was voiced as to the relative roughness of the two engines, but the four-cylinder engine proved as smooth in operation as the six in actual trials. Performance of the airplane with either engine proved to be nearly identical through flight tests.

Selection of the engine finally simmered down to the Continental model, due to a slight cost and initial delivery advantage.

This was one of the first attempts by an airplane manufacturer making a small popular-priced airplane to insist that the engine design furnished would have to embody basic characteristics certain to give the airplane its optimum performance. Usually in airplanes of this class, the aircraft manufacturer has taken what was available and used it as well as possible, or was ignorant of the possible advantages of these special characteristics.

Wisdom of this engine selection policy by Beech has been well rewarded by the fine performance attained by the Bonanza. It could not have been accomplished otherwise.

The old adage says, "the proof of the pudding is in the eating." And the analogy carries over to the airplane because, regardless of the amount of analysis and wind tunnel work, the proof of the airplane is in its actual flying qualities. In general, the flight qualities and performances were as predicted.

As the program of flight testing progressed, three experimentally built airplanes were made available and an intense program of research developed. Engine cooling at first gave difficulties; but by isolating each item of cooling trouble, the matter was soon under satisfactory control through the addition of internal baffles and shielding of exhaust mufflers and heaters.

While the stalling characteristics of the Bonanza were good from the first, it was apparent that the stall under full power with the nose way up could be improved by installing small stall strips on the leading edge, about one-third of the way out. Under this configuration the airplane would stall and settle with the wings in a perfectly horizontal plane – hands off the controls.

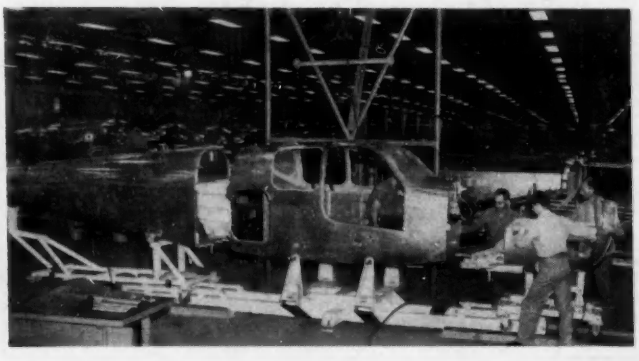
Another thing we found out in the experimental flight program was that the full amount of flap travel could not be practically used. Originally a deflected position of 45 deg down for landing was considered. The full 45-deg flap deflection gave too steep a glide for the light wing loading used and further complicated minimum trim speed problem.

A compromise of 20-deg flap travel gave a nice steep glide, adequate for all practical purposes without causing too serious longitudinal trim problems. Even with this limitation, an increase in

Fuselage Design

The fuselage structure was so made that it could be broken down into relatively small sub-assemblies with maximum simplicity of details maintained.

This shows the method of bringing the separately fabricated fuselage parts into the final assembly jig. Each of the three components shown is assembled from several further broken down assemblies. For example, the side-skin panels are made sub-assemblies with skin, stringers, and sections of bulkhead frames attached. Flush-skin rivets are driven by the Erco automatic riveting machine. Brazier head rivets are hand-driven.

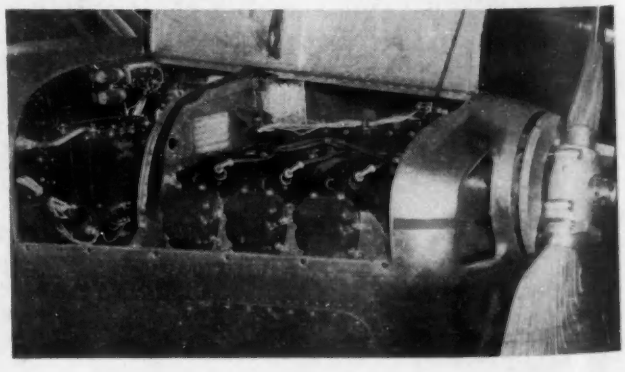


Engine Installation

The Bonanza's 165-hp Continental engine is suspended on four rubber bushings. An automobile-type hood raises for inspection of the engine, accessories, and battery.

The oil cooler is mounted to the rear vertical engine baffle to prevent a stagnant air condition in the accessory compartment. The cooler's discharge air does the circulating.

A small electric motor mounted to the engine crankcase actuates the controllable-pitch propeller. An overspeed governor provides essentially contant speed characteristics for take-off and climb. For cruising, the propeller is manually controlled by a dash-located switch.



elevator chord of about 2 in. was found desirable and has been incorporated in the production airplane. The effect of the smaller flap angle resulted in an increased landing speed of 3 to 4 mph; but the final value was still satisfactory.

In the past it has been the policy of the company to design its structures by analytical methods and to use the minimum amount of structural testing.

In the larger airplanes this is undoubtedly the least expensive method of designing an adequate structure. On a small airplane this procedure works in reverse. It will be found that the minimum amount of analysis for design, followed by testing to destruction of a complete structure for verification, is the least expensive and time consuming. The latter policy was followed in the structural design of the Bonanza.

Each major component was designed, built, and tested to destruction. If the structure did not show evidence, while under test, of carrying the maximum design or required load, the test was stopped and the structure reinforced or "beefed-up" to give the requisite strength.

One further system of ground testing was to expose parts of the airplane – especially the control surfaces – to high frequency low amplitude vibration. Such vibrations may be set up by the engine, surface flutter, and other sources.

So far we have been unable to correlate the various quantities of frequency and amplitude against life expectancy and hours flown. However, the tests have been very useful in providing localized reinforcing to lengthen the life of the part several times when subjected to such vibrations.

We have not been satisfied to just perform the foregoing ground structural, flight characteristic, and performance tests. We realize that many service problems and difficulties can only be exposed through actual normal use of the airplane.

It was decided that an accelerated service test should involve as many hours of flight and as many take-offs and landings as possible under conditions that are average and not above normal experience. Such tests would not only uncover operating and service difficulties with the airplane, but would check the engine and other equipment not being manufactured by us.

It was thought that representative information could be obtained by giving one airplane approximately 1000 hr or three airplanes 500 to 600 hr each of flying. A course was selected of about 170 miles circuit which provided about 10 airport facilities enroute of all grades – from unimproved to class one with paved runways.

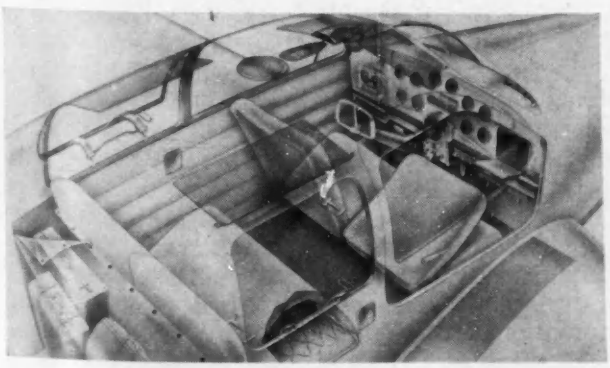
Pilots were instructed to make at least three landings and takeoffs per hr for the average of the endurance run and to the unimproved airports as much as possible. Flights were to be made in all weather and wind conditions and at night up to circumstances that would be considered dangerous. Out of these tests have come considerable benefits.

While nothing of major importance was disclosed, such things as spark plugs, various accessories, engine starting difficulties under weather exposure, and similar problems made it obvious that further improvement was advisable. These observations were passed on to the engineering department and corrective action was taken.

In all, the Bonanza has been developed into an airplane with exceptionally nice handling qualities and stability in the air and on the ground.

Plane Interior The cockpit is designed for comfort and convenience. It affords the pilot excellent visibility both on the ground and in flight. This phantom view shows the neat instrument and control arrangement and commodious baggage compartment.

Included in the center instrument assembly are the engine instruments for oil and fuel pressure, oil temperature, fuel quantity, cylinder head temperature, and generator charging ammeter. The tachometer and manifold pressure are incorporated as separate instruments. Other appointments shown are a cigarette ash receiver, glove compartment, and Motorola radio.



Landing Gear Because of the long wheelbase and wide tread, the airplane is very stable and has excellent ground-handling characteristics. The unusually long strokes of 7.3 in. on the nose gear and 8.0 in. on the main gear insure soft taxiing qualities and the ability to absorb impacts of hard landings.

Both units use air for the elastic medium and oil for energy absorption and rebound check. An electric motor drive in the fuselage retracts the complete landing gear through a nonreversible worm wheel. An uplock mechanism is also provided for the main gear.

With the gear retracted, all openings are completely closed. This feature adds to the airplane's aerodynamic cleanliness.

The Case for Rubber Suspension Sp

BASED ON A PAPER* BY

A. S. KROTZ Chief Development Engineer, Suspensions, B. F. GOODRICH CO.

RUBBER is challenging steel as car spring material for two reasons. It stores more energy per pound than steel; and – properly designed – acts not only as the spring material, but also as a means of positioning parts. This saves weight and cost and eliminates complicated locating bearings and linkages.

The self-locating characteristic of rubber springs is important in another way. Rigid linkage and bearings usually leave the wheel free to move elastically only along a fixed vertical path. Since road impacts are seldom vertical, their longitudinal and transverse components transmitted directly through linkage to chassis incur two objections:

First, a feeling of harshness results and high-frequency vibrations passing into the chassis raise the noise level. Second, unabsorbed impacts mean high stresses.

The trend today is toward a body structure with a much greater section modulus to provide required strength with considerably less weight. But greatly increased vehicle rigidity accompanies this careful material usage giving less weight for the same strength.

Any such increase in rigidity emphasizes the need to provide either greater strength or some added means of absorbing impacts. Specialized separate mountings can turn the trick. But a dual-functioning rubber spring makes a much better mounting than a separate single-purpose one.

Before investigating the possibilities of a rubber spring design that serves as its own mountings and bearings, all related costs must be carefully appraised.

Steel springs cost less than 10¢ per lb for the spring alone; but a fair comparison should add the costs of other required and related parts.

The steel leaf spring is relatively cheap per pound and has done an excellent job in the past. It not only functioned as an elastic member or spring, but it did a fair job of locating and aligning the axle and also served as a crude shock absorber. With the trend toward interleaf spacers and shock absorbers for damping, and with the designer making leaf springs longer, thinner, and softer, the leaf spring no longer serves in three capacities.

Steel coil springs and torsion bars are more efficient than leaf springs in use of material. They both store about three times the energy per pound of weight of the leaf spring. But neither the coil spring nor the torsion bar provides more than the spring function. Both require linkage, guides, and bearings to maintain correct wheel path.

The three types of rubber spring – tension, compression, and shear – are shown and discussed in the panel on the following page.

While the advantages of some of these rubber springs over steel springs are highly attractive, there are some limitations for any rubber spring as well as general misconceptions that the designer should be aware of.

Rubber is not a good conductor of heat. All energy absorbed through hysteresis in rubber appears as heat. Rubber with 90% resilience will dissipate about 10% of the energy stored and returned in each working stroke. (This applies to the working stroke only.)

For example, with 1000 in.-lb of energy stored in the spring in its static position, the working stroke may oscillate between 900 and 1100 in.-lb. Energy converted to heat will then be a percentage of the 200 in.-lb energy change, not of the total static energy.

This energy loss in proportion to the stroke amplitude helps in wheel suspensions by providing some control without objectionable "break away" or dry friction force necessary to start leaf springs in motion. It eliminates the need for separate shock absorbers in some installations.

*Paper "Rubber and Its Application to Suspensions," was presented at SAE Metropolitan Section, New York, Feb. 20, 1947.

ion Springs

Heating is not an important factor since suspension springs will not flex through sufficient amplitude or frequency to matter. But the ambient temperature at which the spring operates deserves consideration. Fatigue life may be sacrificed for any increase above 80F.

At low temperatures rubber becomes stiffer. Any supported mass – such as a vehicle on rubber springs – sets at a lower height in cold than in warm weather. These two contradictory effects sometimes confuse people. They assume that as a spring becomes stiffer, the supported mass stands higher, not lower as it actually does. Neither of these changes is large.

Even the rubber technologists were puzzled at first in one series of tests. They found a spring tested at room temperature, unloaded during the temperature change, and then retested at lower temperature reacted differently than a spring maintained under load during temperature change. Since springs remain loaded in service, tests now are conducted in this fashion.

Considerable progress has been made toward reducing rubber's tendency to stiffen when maintained at low temperatures. Less progress has been made in reducing the change in height of the supported mass. Magnitude of that change for a typical compound is shown in Fig. 1.

Flexing rubber at low temperatures greatly increases hysteresis; so flexing rapidly increases rubber's temperature and aids in maintaining sufficiently uniform height and rate for practially all installations. Commercial vehicle

Compression Bumper – Real problem with rubber springs is to obtain uniform distortion throughout the element. Compression-type or bumper springs are worst offenders in this respect.

Low amplitude of movement also limits use of this spring. Compression springs usually require separate locating linkages.

Compression Ring – This is another form of the compression-type rubber spring. It offers a fairly uniform distortion and is an improvement over the bumper type.

The ring design provides a wide range of stroke. But again it does not perform the locating function itself and must be equipped with separate linkages.

The large exposed rubber surface is another undesirable feature.

Tension Spring – The tension spring – of which the rubber band is the simplest form – has enjoyed wide usage. It offers the designer uniform stress throughout the body and a wide range of deflections.

Chief objection to this type is the need for locating linkage. There is some difficulty in attaching the ends. Compared with total rubber volume, a large portion of its surface is exposed.

Flat Shear Spring – Third rubber spring is the shear type. The simplest form is a flat rubber sandwich bonded to two steel plates. Such a spring deforms parts of the rubber equally – except at the ends. This end effect is a quite serious problem.

In laboratory tests it's sometimes impossible to get more than 150 psi shear before failure starts at the ends.

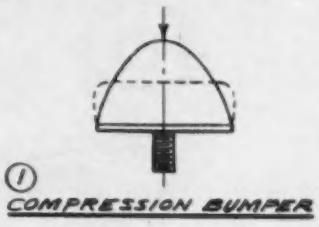
Axial Shear Spring – Rubber in shear can also be made in this cylindrical form. But the spring is still stressed in the axial direction.

Stress distribution is less uniform than in the flat shear spring, with stress concentration at both top and bottom.

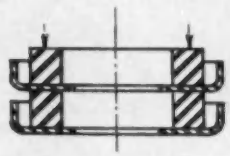
However, the axially-stressed cylindrical shear spring supplies very satisfactory locating or guiding properties and offers a relatively small exposed area.

Torsilastic Spring – Simply a flat shear spring wrapped around to form a continuous cylinder, the Torsilastic spring eliminates the troublesome ends. It also performs its own locating function.

The spring holds up under laboratory tests run at a mean shear stress of 300 psi on the rubber ID. Springs have not been damaged under even 600-psi laboratory tests.



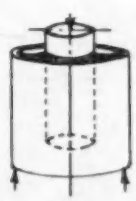
① COMPRESSION BUMPER



② COMPRESSION RING

③ TENSION SPRING

④ FLAT SHEAR SPRING



⑤ AXIAL SHEAR SPRING

⑥ TORSILASTIC SPRING

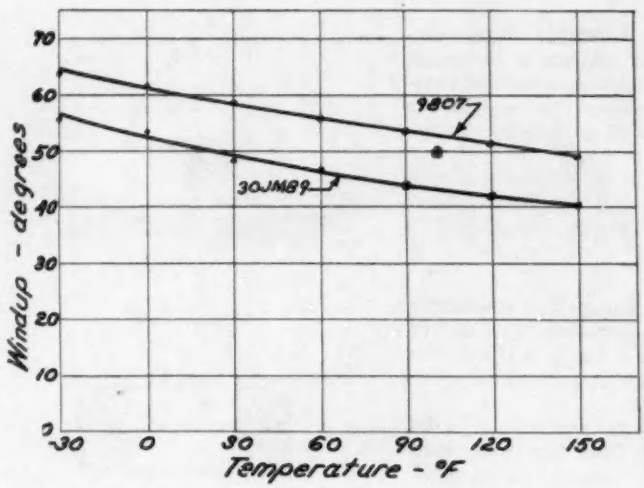


Fig. 1 – When maintained at low temperatures, rubber stiffens and the mass it supports sets at a lower height. This shows the change for a typical compound

installations are less of a problem since a 10% change in nominal deflection at extremely low temperatures represents 0.3 in. on a 3-in. nominal deflection. But the passenger car with a 10-in. nominal deflection might change temporarily as much as 1 in. in height.

All rubber springs tend to creep or take on permanent set in early service. It can roughly be estimated that static load deflection may increase 5% during the first few days that rubber is loaded. After this creep continues at a much reduced rate. One vehicle ran for over two years without adjustment.

Since creep can be expressed as a percentage of spring deflection, it's less important for stiff springs in commercial vehicles than for passenger car installations. A typical creep curve, in Fig. 2, was taken from an accelerated fatigue test that represents about ten years of service life on a bus.

Certain designs on the market have no adjustment for simplicity and low cost. But some form of adjustment is desirable because of manufacturing tolerances and variations in models using the same spring as well as creep of the rubber.

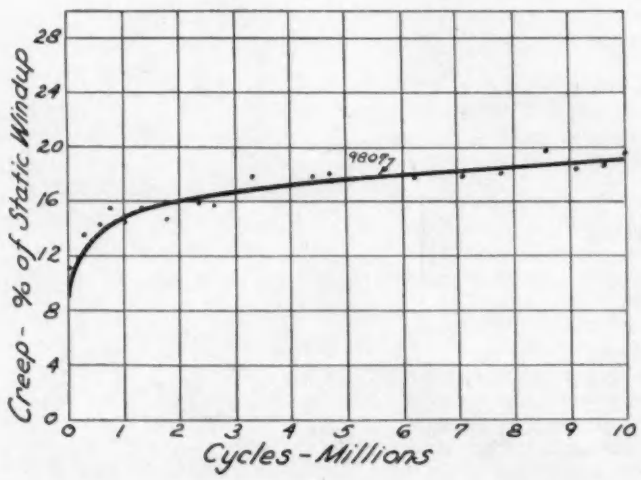


Fig. 2 – The creep phenomenon in rubber, shown here for an accelerated fatigue test representing about ten years of service, is quite pronounced in very early use and then quickly tapers off

One rubber characteristic is frequently misunderstood. There is no measurable lag in elastic recovery of rubber other than limitations imposed by the inertia of the mass moved by the spring. High-speed photographs of a golf ball at the instant of driver impact show the ball flattened to perhaps 60% of its normal diameter. Rapidity with which it springs from the face of the driver depends on the ball's inertia and not on any time lag in the rubber.

While a secondary creep effect does set in after rapid flexing of rubber, it is not related to instantaneous elastic response of the material as a spring.

All self-locating rubber springs provide some resilience in directions other than the principal direction of designed spring deflection. This is a distinct advantage, if properly applied. But the designer must understand the magnitude of this deflection. With suspensions of wheels which steer, steering linkage must be laid out so as not to be adversely affected by these secondary distortions.

Application of a rubber spring to a chassis is largely a mechanical problem. Necessary calculations for the rubber are comparatively simple. It's usually desirable to use as soft a spring rate as possible, within several limitations.

There is usually a limit on allowable change in floor height from empty to fully loaded. Also a soft spring rate requires greater wheel stroke for satisfactory ride. The spring rate must be sufficiently high to give satisfactory control of wheels and to avoid excessive strike-through, roll, and pitching. Shock absorbers can add considerably to control; but they can't make a good ride out of an inherently bad one.

Almost an infinite number of ways of using rubber springs present themselves. Many modifications are also possible in the springs. But greatest progress in the use of rubber will come only when automotive engineers and rubber technicians working together learn each others problems.

HALVING Cab NOISES

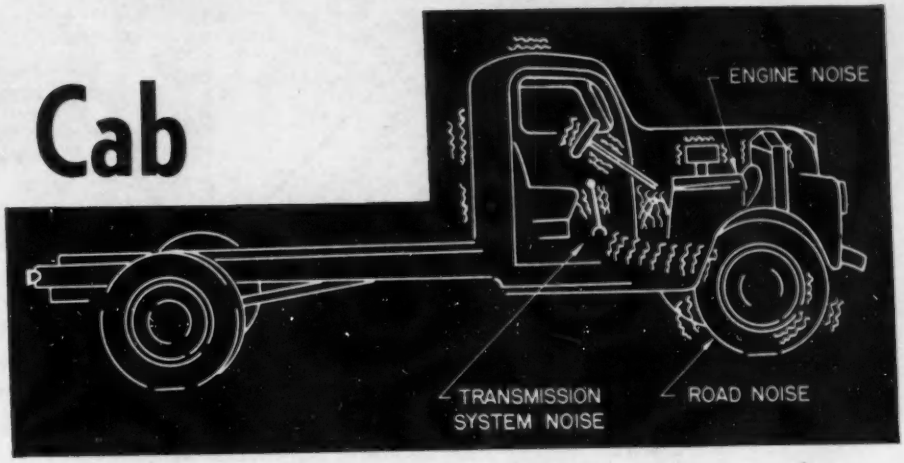


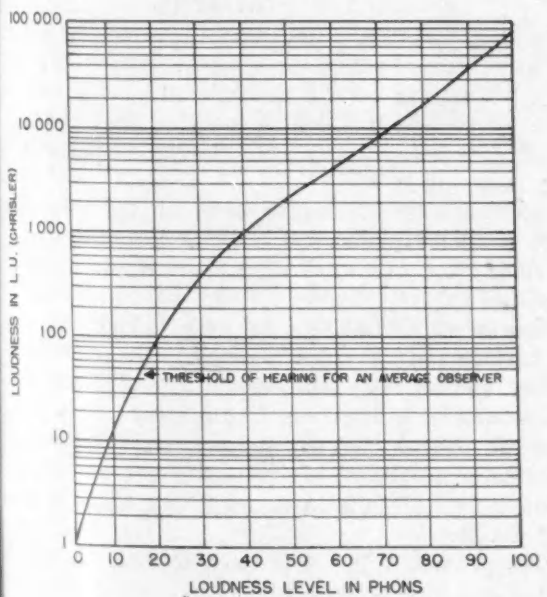
Fig. 1 – How engine, road, and transmission-system noises, as well as sound energy created by the outside air, get into the cab

(This paper will be published in full in SAE Quarterly Transactions)

NOISE levels in a truck cab can be reduced to less than one-half by simple acoustical treatments readily applied on the production line.

Little or no attempt is made in today's trucks to reduce noise levels. Therefore, much can be done without resorting to expensive redesign or major structural or mechanical alterations.

Fig. 2 – Loudness level in phons, an empirical measurement of noise plotted against loudness units, the actual auditory sensation of an average ear produced by a given sound



EXCERPTS FROM A PAPER* BY

Charles W. Thomas and B. G. Radin

Engineering Laboratory, FORD MOTOR CO.

Major sources of sound within a cab are the engine, transmission system, and road and wind noises, as diagrammed in Fig. 1. Depending upon the make and model, there are also more or less airborne noises from the cooling fan, exhaust muffler, and carburetor intake duct.

Direct engine vibrations are transmitted through mounts, and to a lesser extent, through the drive shaft. Each of these, in turn, excites the frame and cab panels. Through diaphragmatic action these vibrations set up additional sound waves in the cab.

Road roughness further excites cab panels, and some airborne sounds often get inside the cab through small holes and openings, and by transmission through the dash and floor.

Acoustical science defines noise as "any undesired sound." Loudness is that quality of sound which determines the magnitude of the auditory sensation of an average ear by any given sound. Fig. 2 shows the relation between loudness level measured in decibels and units of loudness, which, incidentally, have not yet been given a formal name.

Insulation of sound and heat are not to be confused, because sometimes procedures for their elimination are directly opposed.

*Paper, "A Practical Approach to Satisfactory Acoustical Design of Automotive Trucks," presented at SAE National Transportation Meeting, Chicago, April 18, 1947.

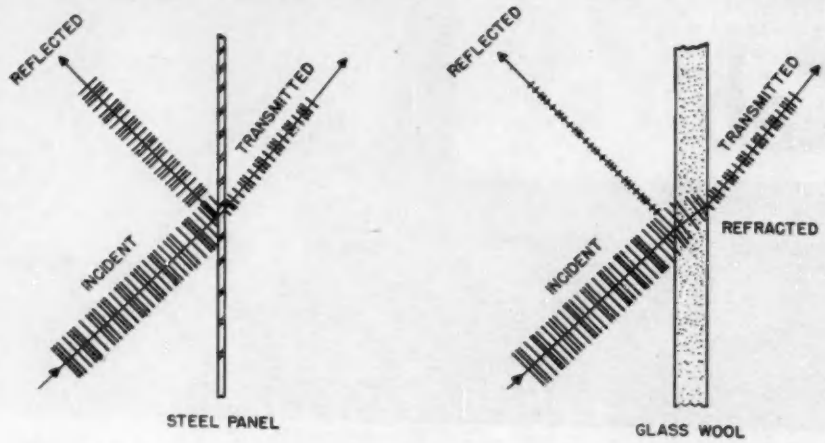


Fig. 3 – Diagram of how a hard surface reflects most of a given incident of sound, transmits most of the remainder, but absorbs little (left) as compared to the behavior of the same sound energy when striking an absorbent barrier, at the right

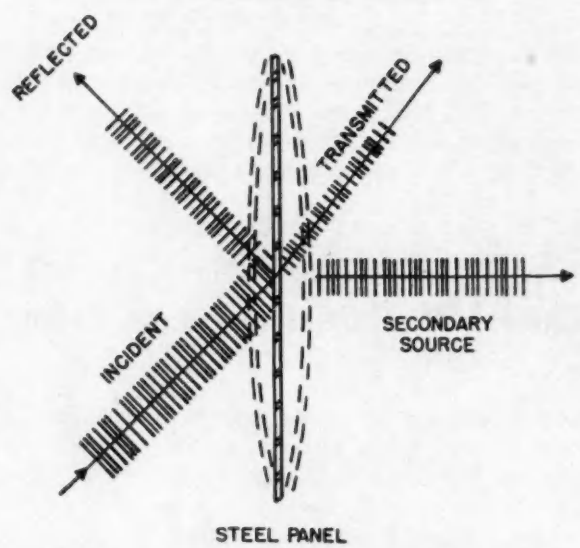
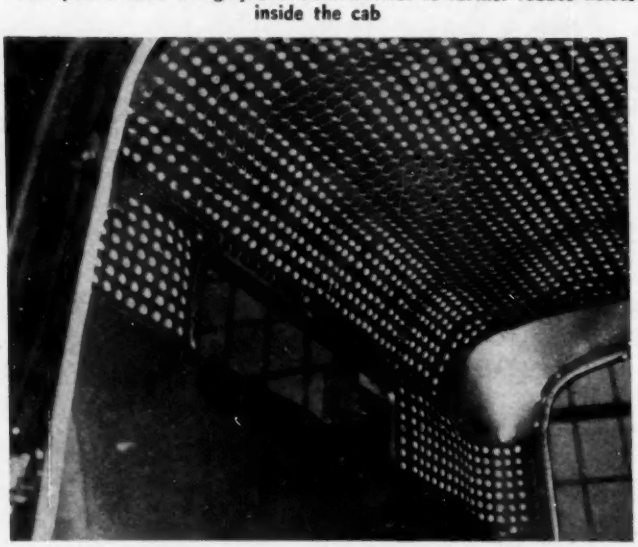


Fig. 4 – Showing how a secondary source of sound is set up by diaphragm action of a thin panel, lower left

Fig. 5 – Perforated back quarter and top trim panels of the test truck. These panels cover a highly absorbent blanket to further reduce noises inside the cab



Nearly all highly porous materials are good *insulators* of heat, and good *absorbers* of sound, but are not necessarily good sound insulators. Sound absorbers are dissipators of incident airborne sound energy.

When an airborne sound hits a barrier, it is reflected, refracted, absorbed, and in some cases it is reproduced. Fig. 3 shows how sound waves behave when striking a hard surface (left) and a soft, porous material (right). The steel panel absorbs little, and most of the sound is reflected or transmitted. The glass wool absorbs much of the sound, leaving less to be transmitted.

When a panel is thin, sound sets up a diaphragmatic action, thus creating a secondary source of noise (Fig. 4).

A number of careful studies made in manufacturing plants and elsewhere show that fatigue induced by noise reduces coordinated reaction. This may well account for a part of the rising toll of highway accidents. Furthermore, effective use of two-way radio demands quieter cabs. On the whole, reduction of the noise level of a truck cab offers an excellent sales appeal for the vehicle.

With these facts and considerations in mind, a study was made of:

- Better sound barriers between the offending noises and the driver,
- Reduction of panel vibrations by dampers or sound deadeners,
- Resilient mountings to isolate the cab, and
- Absorption of sounds within the cab itself.

After evaluating commercial sound deadeners, the Chemical Engineering Laboratory of the Ford Motor Co. developed an inexpensive rubber base acoustical material of high density named barytes. A square foot of this deadener 0.1 in. thick weighs about 1.1 lb.

In its present form it is backed with canvas, is flexible, and can be molded or formed. A sheet of

jute increases heat insulation and makes the material easier to cement to metal surfaces.

Next step was to acoustically treat a truck for test. The cab interior was lined with this material, and at opening sheets of the barytes was overlapped. The standard production acoustical treatment of the back panel needed little additional deadener spraying, but the doors, as treated in production, were satisfactory.

Original cab supports were removed, and replaced by shear-stressed rubber mounts. Effectiveness of this mounting is lessened, of course, by bolting the steering column rigidly to the frame and cab.

Absorptive qualities within the cab were further improved by installing a highly absorbent blanket behind the top and rear quarter trim panels of the cab. These panels were perforated (Fig. 5) but it was found that the shape and size of the perforations in these trim panels were unimportant.

Work has not been completed on improving the noise characteristics of the air intake silencer, but a possible solution is shown in Fig. 6. Here a series of labyrinths, to form resonant chambers, is proposed. It would be acoustically coupled to the carburetor, and fitted, as shown, under the hood.

Fig. 7 shows comparisons of three ½-ton trucks. The noisiest is the standard production model, and less noisy is the one where the cab only has been acoustically treated as described. The quietest, with a noise level less than one-half the production model, is the acoustically treated cab, but with the rubber mounts. The test truck had 7000 miles when prepared for the tests.

Although no investigations have been made studying the effects of noise in mobile equipment, various scientific groups have studied this problem in treated and untreated factories, and fatigue induced by noise in combat aircraft cockpits.

During the war the Allied Air Command directed a study to solve the problem of casualties of bomber and fighter pilots who, upon return to an adequately protected home base, would overshoot, undershoot, and otherwise fail to make safe landings.

Despite widespread use of automatic pilots, these accidents at home base continued at an alarming rate.

Unexpectedly, it was found that the frequencies in the high region of the spectrum, although masked by those in the lower region, were increasing the pilot's reflex time.

Suitable acoustical treatment of the cockpit corrected the difficulty of pilot fatigue and casualties were reduced to a minimum because of that reason.

A survey of three industrial plants, before and after acoustical treatment, reduced the accident rate per employee nearly one in 100 per month.

Another study disclosed that after seven hours of exposure to noises of 115 decibels, a reduction in the time of coordinated serial reaction was 5.4%, with an accompanying decrease in auditory sensitivity, and reduced speed of focus of the eye.

All of these findings indicate that a quieter truck would be a safer truck.

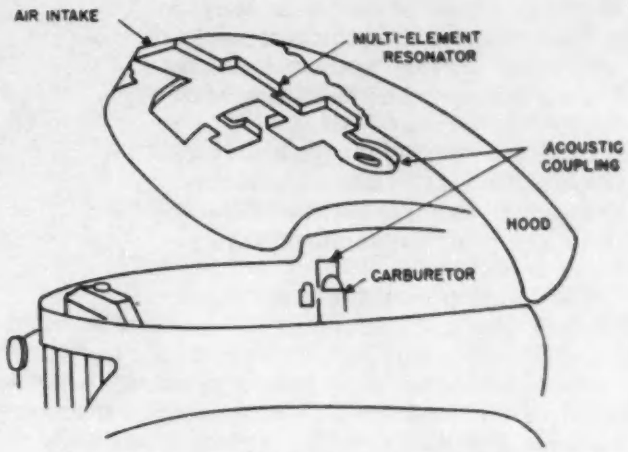
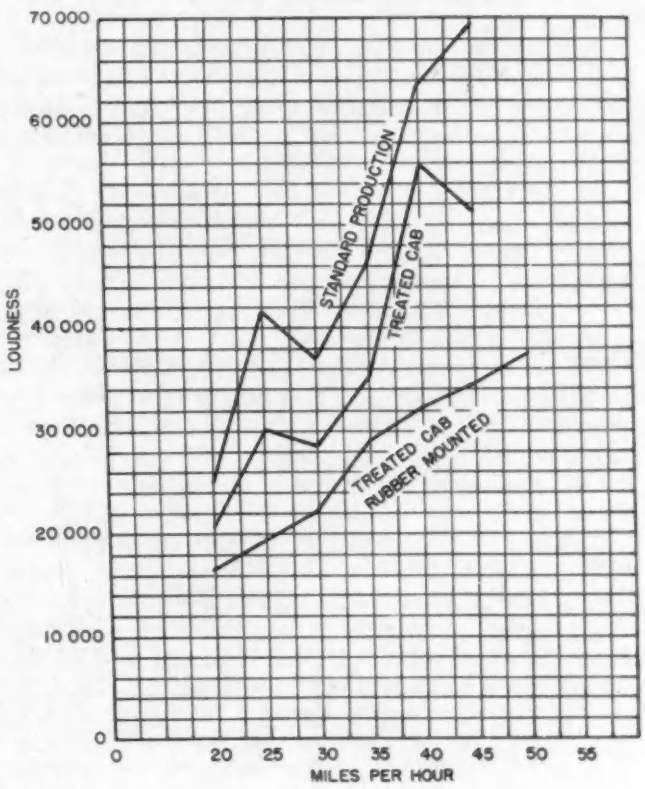


Fig. 6 – Scheme of experimental air intake silencer

Fig. 7 – Comparative test result of three 1½-ton trucks at from 20 to 45 mph



TOMORROW'S

BOTH a long-range and a short-range type of airplane will be needed to meet the requirements for airfreight service indicated in the United States in the next few years.

The long-range plane will be needed for through-express service; the short-range plane to accommodate traffic moving between demand stops and principal points of different trade areas.

The long-range plane must be capable of operating from coast to coast with a maximum of one refueling stop, even on the tough west-to-east direction, where a minimum *nonstop* speed of 300 mph will be necessary to overcome the time differential and get perishables to early market; the short-range plane should be able to fly 800-1000 miles without stop for refueling.

Payload of the long-range ship should be limited to 20,000-25,000 lb, as higher payloads would require prohibitive loading and unloading time. Capacity of the short-range plane should be about 10,000-12,000 lb.

The larger ship will probably be a 4-engine job, adaptable to overwater operations, and capable of flying at sufficient altitude to minimize the interference of en route weather. A twin-engine design would be most desirable for the smaller ship.

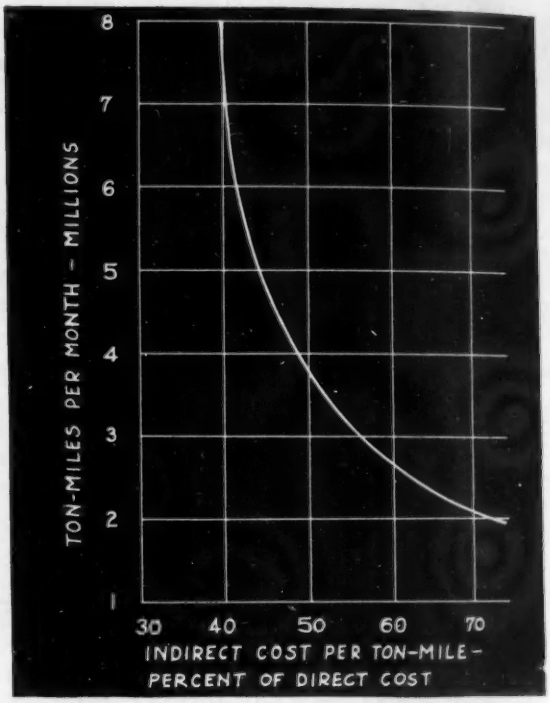


Fig. 1 – Indirect cost per ton-mile plotted against ton-miles per month

Design Requirements

Both airplanes must have a level floor of truck-bed height, and should incorporate the latest developments in radio, instrument, and operational flying equipment.

A lot of indirect costs can be designed out of this equipment, but it should not be at the expense of reliability or dependability. A delayed passenger may become irritated, but he will not spoil or go out of date.

The total volume of space allowed for freight should be in one clear and unobstructed compartment. The structure should be designed for a density of 6-6.5 lb per cu ft of space occupied by freight, which would cover such loads as cut flowers, millinery, and furniture.

Naturally, cross-section and longitudinal shape of the fuselage affects the amount of space required to hold a given amount of freight. A rectangular fuselage is desirable because it allows the most efficient use of space and also is the easiest to load.

It should be possible to determine compliance with center-of-gravity limitations by a visual check, except in extreme cases. For example, an airplane should be able to leave Boston with one-third the allowable load located in one end of the cargo space, proceed to Philadelphia for the remainder of the load, have half the payload removed in South Bend, and continue to Chicago, all within center of gravity limits. This must be accomplished without the necessity of shifting cargo at en route stops, and can be done if:

1. There is a generous allowance for c.g. travel.
2. The operating weight empty c.g. is located in both the center of the allowed travel and in the center of the constant fuselage section freight space.

Stowage of freight can be greatly improved by designing the cargo compartment walls, floors, and ceilings smooth and free from discontinuities. Cabin lights, tiedown fittings, and the like should be flush.

Full cross-sectional loading should be used when

*"Suggested Design and Operating Requirements for Cargo Transports" was presented at the SAE National Aeronautic Meeting, New York City, April 11, 1947.

'S CARGO NEEDS

Long- and Short-Range Planes, Special Designs

BASED ON A PAPER* BY

J. E. Winchester

Chief Engineer, Slick Airways, Inc.

possible, as it permits rapid loading and eliminates the necessity for cargo tiedown. Fore-and-aft shifting can be prevented by readily installed nets or barriers. An airplane recently ran off the runway, crashed through a fence, plowed across a ditch, and wiped out the landing gear. The cargo remained in its original position and suffered no damage because it was loaded in this manner.

When only part of the cross-section is used, cargo should be held in place by nets of 2-in. heavy webbing. These nets should be fabricated in about 10-ft square sections with the webbing forming a 10-in. grid pattern. At least every other web intersection should incorporate a grommet. Edges of nets should incorporate quick means of attachment, both together and to the fuselage tiedown provisions.

Rows of flush, easily cleaned and replacable tiedown fittings should be provided at the base of each cabin wall and 30 and 60 in. from the floor. Three rows should be spaced spanwise across the floor. All rows of tiedown fittings should extend the full length of the freight cabin, spaced 20-25 in. apart.

The cargo floor should be metal-clad, waterproof, and covered with a readily removable wearing surface. Metal skid strips should be spaced 12-15 in. apart for the full length of the floor. All door sills should be easily replaceable and fabricated of stainless steel sheet to resist the wear and tear of loading operations. The floor structure should be designed for 150-175 psf cargo loading. Floor beams should be designed to permit even higher concentrated loads.

Pressurization is not considered necessary for the cargo compartment, although the crew compartments of both planes should be pressurized.

Air conditioning requirements for freight planes have been the subject of considerable discussion. With the speeds offered the elapsed time the commodity is in transit is only 1/15-1/20 that required for surface transportation. It is believed to be impractical, therefore, to attempt to precool the produce in transit.

Procedures must be developed to permit the rapid removal of field heat from the tree- and vine-ripened perishables before shipment. Then the cooling requirements for the aircraft need only be capable of assuring minimum temperature rise of the commodity in transit.

In general, it appears that an efficient insulation installation is of primary importance, and that possibly cooling provisions for use during "let-downs," while on the ground, and during "climb-outs" will be the maximum necessary. Experience indicates that a cabin air temperature of 60 F would be sufficient. A large volume of air circulation will be necessary to carry off the "vital heat" generated by the produce.

Even heat, free from cold and stagnant spots throughout the cabin, is needed for winter operation. The most critical operational heating condition occurs when a full load of cut flowers is carried, the problem being to protect the complete load from freezing without damaging the flowers that are stacked against the sides and top of the fuselage. Here good circulation and a high rate of air exchange are required. A sufficient amount of heat must be available to permit operation with cabin temperature at 70 F in at least —25 F weather.

Auxiliary power must be provided to supply cargo lighting, heating, and cooling when the airplane is on the ground.

The cockpit should contain provisions for a nor-

mal crew of pilot and copilot, with at least two additional seats for check pilots and crew transfer and training. There should be independent automatic heat control for the cockpit.

Altitude performance must be such that it will permit operation over all terrain within continental United States under instrument conditions.

Airplanes should be equipped with tricycle landing gear, fire detection and extinguishing means, thermal anti-icing and instrumentation that will permit reliable operation under all weather conditions when flying either on or off regular airways.

The aircraft will probably be of the high wing type, despite a theoretical economic penalty, to avoid damage to wings by loading and unloading trucks. The under wing surface of the outboard of the nacelles should clear by 1 ft the highest tractor-trailer combination, which is limited by law in most states to 12 ft 2 in.

Movement of trucks and trailers about the airplane almost dictates the use of two doors, which should be on the same side or at least confined to one end and one side. One door should probably be located on the left aft side of the fuselage, clearing the trailing edge of the wing center-section as much as possible. This door should be at least 6.5 ft high and 8 ft wide, and should open upward to reduce truck damages and offer some protection from the elements.

The best position for the other cargo door is the nose of the plane to provide straight away nose loading and to permit the pilot to maneuver the plane directly to the warehouse dock and, after loading, to back away. This opening, probably with the nose split and opening to either side, should be at least 6.5 ft high with the maximum permissible width in keeping with the airplane contour.

Economic Considerations

The direct operating cost per ton-mile is not the only criterion for determining the merit of a plane. A low figure for such costs must not be obtained at the loss of utility, speeds necessary to give the required service, reserve power, or functional dependability.

Indirect operating expenses can be materially decreased if proper steps are taken in the design stages. The following items should be checked for reductions:

1. Number of cargo handling personnel.
2. Number of aircraft service personnel.
3. Number of insurance claims for spoiled, frozen, or otherwise damaged cargo.
4. Delay time resulting from ground damage.
5. Capital investment in cargo handling equipment and its maintenance.

A study of airfreight operating costs based on existing equipment for a volume of business ranging from 1.5 million to 10 million ton-miles per month was undertaken to establish the indirect operating expenses that can be expected. Fig. 1 indicates that a marked reduction in indirect expenses can be expected until a rate of 7.5 million ton-miles per month is reached.

This investigation was based on the average freight shipment moving 1600-2000 miles with stops for fuel at the optimum points for the airplane within geographical limits. A utilization of 10 hr per day and a load factor of 80% was assumed. Above about 3 million ton-miles per month these assumptions should be conservative. Present load factors are only 5-10% below the 80% assumed. Correct balance of commodity and directional rates, coupled with the probable use of freight forwarders and consolidators is expected to produce stockpiles and backlogs that will permit full realization of this 80% load factor.

It is expected that, although the majority of aircraft now in use were obtained at very low prices, the 100¢ on the dollar cost of replacement equipment will not prevent substantial decreases in the direct operating costs. In a like manner, provided the design includes due consideration for indirect cost reduction, a decrease in the indirect operating cost will result.

A brief investigation indicates that the direct and indirect costs would retain about the same relationship as shown in Fig. 1.

Total operating costs per ton-mile for both the airplanes must be 7.5-8¢ if airfreight is to compete successfully with other forms of transportation.

Regulations

Two years ago the Aircraft Industries Association unsuccessfully proposed an all-cargo regulation. Since then, millions of ton-miles of airfreight have been transported commercially under varied operating conditions. A review, therefore, of present regulations and their effect on all-cargo operations should be made – and unquestionably will be.

For example, it might be found desirable to change the en route climb requirement. Since airfreight operations are contemplated at relatively high altitudes, for the most part, it is possible that a regulation providing equivalent safety could be devised that would permit clearing en route obstacles at the absolute 1-engine inoperative ceiling of the airplane with, of course, due allowances for temperature, turbulent air, and the actual weight of the airplane. The regulations could require that the flight plan include a cruising altitude enough in excess of the 1-engine inoperative absolute ceiling to permit the flight crew to diagnose the emergency, and put into effect the necessary engine-out procedure. Under actual operating conditions a plane will drift down and stabilize at a higher altitude than that possible when a climb must be negotiated after the emergency condition occurs. Instead of a minimum rate of climb, therefore, the regulation could require a minimum rate of descent.

BASED ON A PAPER* BY

H. W. Luetkemeyer

Chief Engineer, Cleveland Graphite Bronze Co.

Bearing Maintenance

(This paper will be published in full in SAE Quarterly Transactions)

THINWALL precision bearings fail usually because they are improperly installed, because engine ratings have been increased without fundamental design changes, or because operators use the vehicle more severely than the engine design permits. They seldom fail because of poor metallurgical or chemical quality.

Engine designers, realizing that operators will not revert to conservative prewar demands, are reproportioning blocks, working on larger diameter crankshafts, designing more adequate ribbing and improved bulkheads, and studying better location of the bearing cap in relation to the case.

On the other hand, the vehicle engineer cannot solve problems for operators who permit scaling in water jackets, lack of coolant, and other careless practices in maintenance. Responsibility for good bearing life will remain with operators and repair shops.

Proper Bearing Installation Essential

Initial bearing installation must be checked for bore size, distortion, shaft finish, and properly stamped mating parts to identify their location and position.

Main bearing caps must be investigated to see that parting line surfaces are clean and have no burrs. Nuts must be loosened to relieve strain resulting from operation in the case or cap.

Proper torquing of nuts is essential to seat the bearing properly in the case bore. Best assembly is achieved with a properly set torque wrench, alternating from one side of the bearing to the other.

Bore size is then measured with a dial gage, preferably set with Johansson blocks or ring gage. Out-of-round, average diameter, cap and twist are checked by front and rear measurements in each bore of the vertical and horizontal diameters on each side of the split line, and at the 45 deg diameters. If the bore is over 1½ in., a center reading is also taken. Maximum taper of 0.0005 in. and an out-of-round of 0.001 are allowable.

Check Alignment

When main bearing bores are found within proper limits and not greater vertically than horizontally, the main bore alignment must be checked. An alignment bar, 0.0005 in. under the low limit for diameters up to 4 in., 0.00075 under the low limit for diameters from 4 to 6 in., and from 0.001 to 0.0015 for diameters over 6 in. is preferred to using the crankshaft for this checking using Prussian blue.

Careful checking and measuring the crankshaft itself is essential. Visual examination of surface condition often discloses nicks, scratches, and burrs around the oil holes. Horizontal and vertical measurements at the front, center, and rear of the shaft journals and crankpins should be micrometered with an instrument with 0.0001 in. vernier graduations.

Each crankpin is positioned at top dead center for reference, and measurements are taken of vertical and horizontal dimensions of all mains, to check for proper size, out-of-round, taper, and convex or concave conditions of each.

Main and pin journals should be held to roundness within 0.0003 per in. of diameter up to 5 in., and the maximum allowance for taper over the entire surface should be held to 0.0005 in.

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* Paper "Automotive Bearings from the Service Viewpoint," presented at the SAE National Transportation Meeting, April 18, 1947)

HELICOPTER Designers Weed Ou

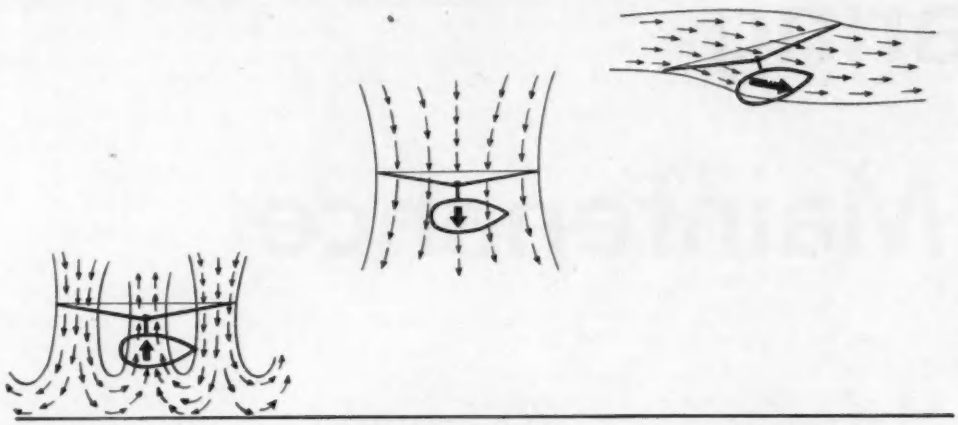

Fig. 1 – Helicopter airflow patterns for these three flight conditions influence design of air inlets and outlets

ATTENTION to helicopter engine installation details such as cooling, type of pylon suspension, and accessibility, marks operational success or failure, assuming the designer has selected the best available powerplant for the job.

With all aircraft piston engines large quantities of air must be maneuvered into and out of the engine installation to carry away the heat efficiently. The designer must properly locate air entrances and exits such as air inlets, engine exhaust outlets, and oil cooler outlets.

Major objective in locating these inlets and outlets is to keep the hot exhaust air from engine, oil cooler, or exhaust systems from raising the temperature of incoming air. This problem is particularly difficult with the helicopter. Lack of ram pressure during hovering and eccentric airflow patterns of rotary wing aircraft are the main reasons.

Fig. 1 illustrates some of these typical patterns.

In hovering – the most critical condition from a cooling standpoint – airflow direction about the body when near the ground is entirely different from that for a ship high enough to be out of the "ground effect."

When near the ground, general airflow near the center of the rotor is upward due to a reflection of the pattern. With the ship high enough to minimize the reflection pattern, the flow reverses and is generally downward. The third condition is encountered in forward flight. Here the pattern is essentially horizontal with flow toward the rear. Forward speed creates the major flow component as rotor down wash is comparatively small.

These three patterns should guide the designer in selecting air inlets and outlets – especially for recirculation considerations.

The cooling air inlet need not be a ram type since a means other than ram pressure will cool the engine. But the available velocity of forward flight should be used if it can be done more efficiently than with a cooling fan. An effective ram inlet and ducting can provide additional power for the rotor that normally is needed for cooling.

Either a fan or an ejector can cool the helicopter engine. Most common method is a fan driven directly by the engine and located on the cold side of the cylinders. This fan doubles as a flywheel.

This feature establishes new criteria for fan design since the fan blades, disc, and attachment to the crankshaft must be designed for violent torsional accelerations in starting. It also must be designed to take the roughness during idling. The fan's inertia must provide satisfactory engine idling characteristics; the rotor is not engaged during starting and idling and there is no propeller to act as a flywheel as in an airplane.

But the fan also must be light enough to be suspended by a spider web. The designer himself has to resolve contrary requirements of light weight and large inertia. A well-designed helicopter cooling fan will weigh between 0.05 and 0.08 lb per engine bhp.

Power absorbed by the cooling fan provides more food for thought. If not necessary for cooling, this power can be converted into useful load. Engine cooling absorbs 3 to 5% of brake horsepower. At current power loadings of 10 to 12 lb per bhp, this assumes more than peanut proportions of potential lifting capacity.

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* Paper "Helicopter Powerplant Installations," presented at SAE National Aeronautic Meeting (Spring), New York, April 9, 1947.

Out Engine INSTALLATION FOIBLES

BASED ON A PAPER* BY

Robert A. Wolf Helicopter Design Engineer **and Carl P. Spiesz** Powerplant Group Engineer

BELL AIRCRAFT CORP.

Converting all cooling fan power to lift in a 500-hp machine – that lifts about 5000 to 6000 lb – would gain 150 to 250 lb in lift. In terms of useful helicopter load this could equal 10 to 15% – more than just a detail to the helicopter designer.

But power-costly cooling with a fan need not penalize the design. The exhaust ejector, an alternate method, consumes very little power. Long used in pumps not requiring high efficiency, the ejector principle is now being applied to aircraft

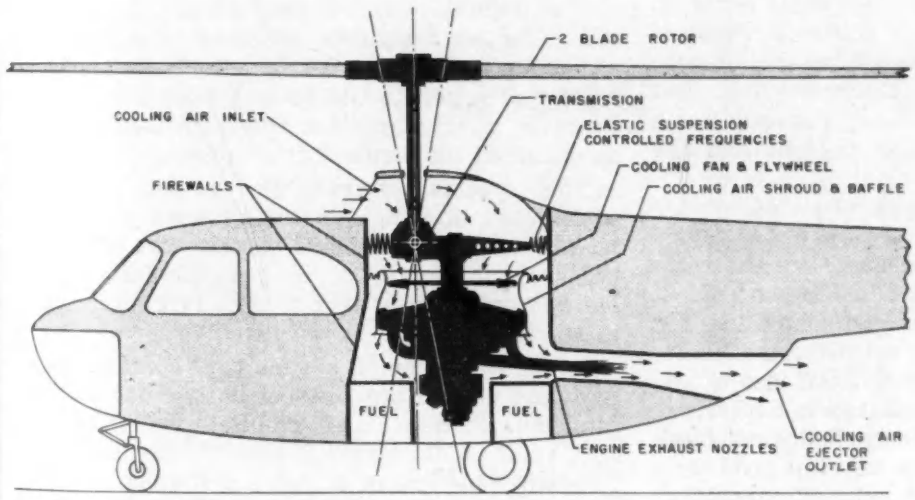

Fig. 2 – The flexible pylon construction, as in this five-place Bell helicopter, isolates the rotor and engine installation and their annoying vibrations from the body. This model also features a cooling combination of fan and ejector for greater efficiency

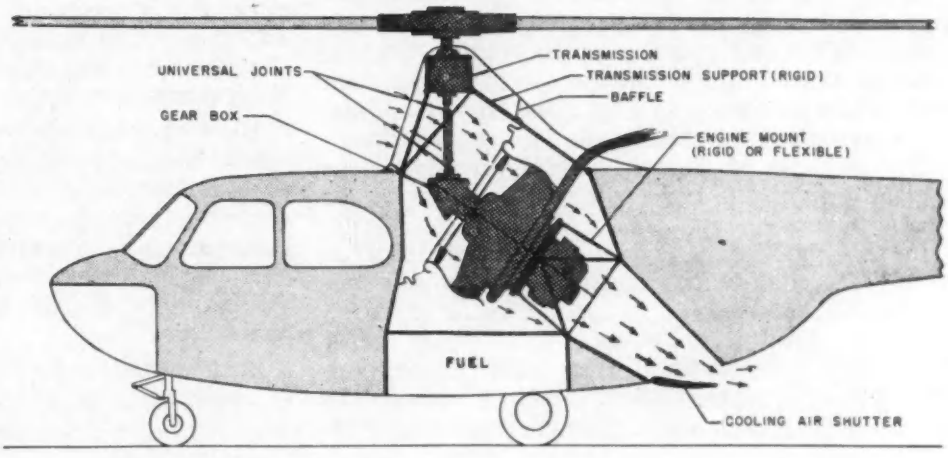

Fig. 3 – Difference between this rigid pylon installation and the elastic type in Fig. 2 is that here the rotor, mast, and engine may be mounted separately

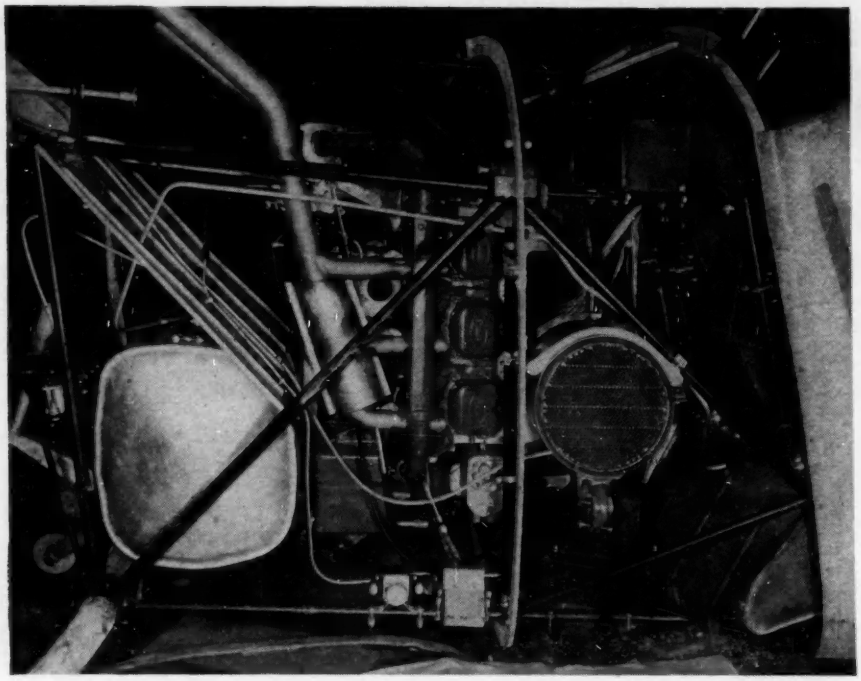

Fig. 4 – Necessary crowding of accessories and components in the helicopter powerplant zone challenges the designer's ingenuity to provide accessibility

for pumping cooling air. Engine exhaust gas energy imparts the pumping action.

For use in the helicopter, the ejector can be designed for pumping across a pressure differential. It can pump large volumes of air at pressures of 5 to 8 in. of water. The ejector can completely cool the more modern good-cooling engines that require low mass flow and pressure drops. Some older engines are more difficult to cool and the ejector becomes marginal.

In such cases a fan can supplement the ejector to give full cooling.

Ejectors fall into about the same weight category as cooling fans – 0.075 to 0.090 lb per bhp.

The ejector appears to give you something for nothing. But it actually costs a little something – the power to carry its weight and the loss of exhaust system thrust. The second item is not important in helicopters because the craft doesn't have high enough forward speeds to develop good propulsive efficiencies from direct exhaust thrust.

An ejector as the only source for cooling air pumping leaves the design with a serious deficiency. What will you use for the engine flywheel without a fan? Using an ejector in conjunction with a fan, as shown in Fig. 2 for the Bell Model 42, represents a satisfactory design compromise.

Two schools of thought prevail in suspension system design: the rigid pylon and the flexible or elastic pylon.

In the rigid pylon system the rotor mast is rigidly attached to the fuselage. The engine can be remotely located, as in tandem rotor arrangements, or closely coupled, as in single rotor ships. Main point here is that rotor, mast, and engine are separately mounted and elastic problems are independent of each other. The gear reduction box in the rigid pylon is usually as close to the rotor as possible. It's driven through a torque shaft and universal joint.

Fig. 3 illustrates a typical rigid pylon installation. The engine can be mounted from its normal mounting points; it can be either elastically or rigidly attached to the fuselage. In this case it's mounted rigidly from the normal rearward points, as designed for airplane installations.

This system generally is coupled with fully articulated and rigid rotor systems with rotors having an odd number of blades. The odd blades balance out certain of the periodic forces acting on the mast during flight so that a rigid connection to the fuselage can be tolerated.

In the elastic pylon system the rotor mast, gear box, and engine are connected together and suspended as a single mass. The Bell two-bladed "see-saw" rotor machines are designed with this system. The two-bladed rotor requires a simpler rotor and hub and much less storage space than three-bladed ones. But it needs a different suspension to exploit effectively this simplicity. That's the reason for the flexible pylon that isolates rotor suspension from the body through elastic supports.

Here the large elastically-suspended mass of rotor, transmission, and engine absorb and dissipate rotor-created vibrations. This isolates both rotor and engine vibration from the passenger compartment. Absence of direct metal-to-metal contacts between pylon and body also eliminates from the body high-frequency buzzing type of noisy vibrations.

Such a system in the Bell five-place helicopter is shown in Fig. 2. In this case the engine is

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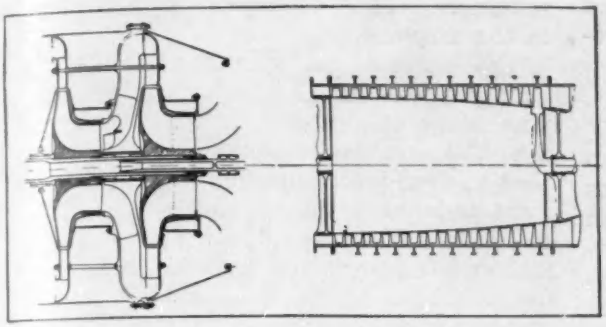


Fig. 1 – Comparison of centrifugal (left) and axial-flow (right) compressors

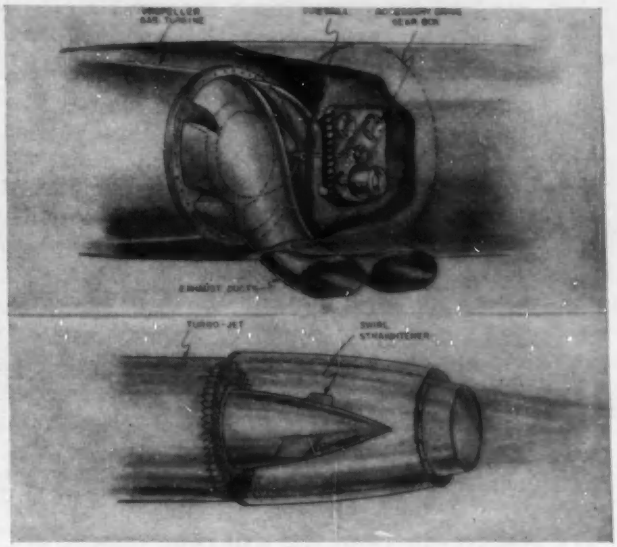


Fig. 2 – Comparison of turboprop (upper) and turbojet (lower) exhaust systems

DESIGNING

Future Turbo Engines

BASED ON A PAPER* BY

EARL V. FARRAR

Manager, Gas Turbine Division
Wright Aeronautical Corp.

MANY interesting changes seem likely in turbojet and turboprop engines in the next few years. Changes in both the design and installation phases may include the following trends:

1. Centrifugal compressors will probably give better results in the immediate future from the standpoint of the operator, but the axial compressor may eventually win out because of its better efficiency.

2. The can type of combustion chamber, which has been used in early turbojet engines, will probably be largely supplanted by the annular type.

3. Variable area exhaust nozzles will probably become widely used in turbojets, despite present design difficulties. It isn't likely to be used on the turboprop engine.

4. Exhausts straight to the rear and of minimum length are required for turbojets, but for the turboprop the exhaust annulus can be divided into segments and brought together at a convenient point, thus simplifying installation.

5. Various expedients will be devised to improve the flow of air over the reduction gear and propeller on its way to the compressor of the turboprop engine.

6. More attaching points will be used to mount the turboprop engine than are conventionally used with reciprocating engines.

7. A separate accessory box will come into widespread use because of the widely different accessory requirements of airplanes.

8. The majority of turboprop and turbojet engines will incorporate complete integral lubrication systems.

*"Design Trends in Turbojet and Turboprop Aircraft Engines" was presented at a meeting of the SAE Southern California Section, Los Angeles, Calif., Feb. 6, 1947; and at a meeting of the SAE San Diego Section, San Diego, Calif., Feb. 7, 1947.

9. Fuel consumption may be lowered by such means as a ducted fan on the turbojet and regeneration on the turboprop engine.

Compressors

The centrifugal compressor has extreme ruggedness if foreign objects enter, its performance does not deteriorate to any measurable extent with an accumulation of dirt in the passages, it is not susceptible to damage from ice or great deterioration in performance from the presence of a small amount of ice. The outstanding advantage of the axial-flow compressor is a somewhat higher peak efficiency, which reflects itself in lower specific fuel consumption of the engine. It is of smaller diameter and greater length for a given airflow and compression ratio. Relative size of the two types for a given airflow is indicated by Fig. 1. The disadvantages of the axial compressor are its relatively fragile structure, susceptibility to damage from ice, and susceptibility to deterioration in performance from an accumulation of dirt on the blades.

Combustion Chambers

All of the early turbojet engines utilize can-type combustion chambers. The annular type, however, seems to have some ultimate advantage in that it provides the largest possible flow area for the combustion air in passing from the compressor to the expansion unit and the axial velocities are, therefore, comparatively low. Lower axial air velocity may make the annular chamber basically a shorter design than the can type. It is probably easier to get the necessary structural support between the compressor and the expansion units because the outer skin of the chamber readily provides such support, and it is easier to provide airtight, fuel-tight, and oil-tight joints in the engine structure.

Exhaust Nozzles

The variable-area exhaust nozzle permits adjustment of the jet velocity to obtain minimum fuel consumption and maximum thrust as desired under various conditions of flight. Design difficulties, which, it seems certain, are caused by the extreme heat, will be overcome, so that this type of nozzle will be widely used on turbojets. Because in a turboprop a relatively small portion of the total thrust available is generated in the jet, it is doubtful if a variable-area jet can be made to justify its weight and complication, with attendant service problems, on this type of powerplant.

Exhaust Systems

The exhaust system configuration for turbojets is quite well established by the high exhaust velocity and temperature. Reasonable jet outlet velocity and temperature aft of the turbine wheel are, today, 1800 fps and 1150 F, respectively. Such a system exhausts straight to the rear and is of minimum length consistent with engine location in the airplane.

The losses in the exhaust system of the turboprop are not quite so important because a small percentage of the total thrust is generated by the jet. The selected velocity may be low enough so that at near maximum flight speed it is just sufficient to remove the exhaust gas volume without actual loss from drag of the open end of the pipe. Exhaust temperatures probably will range in the neighborhood of 900 F. Liberties may be taken, therefore, in the form of reasonable bends. The exhaust from the turboprop structure should be terminated as close to the turbine wheels as possible to leave all available length for the installation engineer. Dividing the exhaust annulus into segments permits structural members to pass from the outer shell to the center of the machine for the purpose of supporting the rear bearing or other parts that it may be desirable to place to the rear of the turbine wheels. It permits bends in the pipe in a shorter axial distance than if one large pipe were used. Such a divided exhaust system can be brought together at any convenient point and discharged through a single orifice. Typical turbojet and turboprop exhaust systems, as just described, are shown in Fig. 2.

Reduction Gear and Propeller

The principal feature of the turboprop that distinguishes it from the turbojet is the presence of a reduction gear and propeller. In any conventional design this unit is at the front of the machine and is an obstruction to free flow of air into the compressor. Attachment of the gear directly to the turboprop necessitates enlarging the air inlet to an annulus around the gear case or the introduction of the air from the sides. Introduction from the sides would probably lead to high losses because of the right-angle turn when entering the compressor. Introducing it through a forward-facing annulus about the reduction gear housing seems to be the lesser of the two evils. Then it must be drawn over the propeller hub and through the propeller blades, which at the radius of the opening are apt to be practically round. To accomplish this with a minimum loss, some suggest that the NACA Type E cowl (Fig. 3) will receive serious consideration. A solution more certain of good results is the use of a reduction gear forward of the engine and connected to it by an extension shaft, somewhat as shown in Fig. 4. The use of an extension shaft to facilitate air inlet becomes of great interest if dual-rotation propellers are used.

Mounting Problems

The method of mounting a turbojet is reasonably well established because it is pretty well buried in the fuselage or wing. These machines are generally supported from somewhere near their center

of gravity, with an additional support at one end to provide stability.

The turboprop presents a more difficult mounting problem. If an attached type of reduction gear is used, it is desirable to mount the engine well forward in the wing, with the propeller in relation to the wing somewhat as with conventional reciprocating engines. The turboprop is conveniently and economically a monocoque structure, so that the problem is to mount a monocoque structure, the engine, to a monocoque structure, the airplane. The natural method is by the use of a large number of connecting points to eliminate stress concentration in either structure. This method, however, increases maintenance problems and makes it more difficult to incorporate a dynamic mounting, should one be required. Compromise that some expect to see made will be the use of a somewhat larger number of attaching points than are conventionally used with reciprocating engines. A turboprop may also be mounted from somewhere near its center of gravity, which seems to simplify the application of dynamic mounting, if required, but does not materially alter the fact that a number of mounting points are desirable from the structural standpoint. Center mounting is probably the only reasonable method for the turboprop with extension shafting, as with a turbojet engine. There is no reason to believe that the turboprop itself will have to be mounted dynamically with this configuration, but there are some who believe that it will be necessary to mount the propeller reduction gear in this way. Mounting the gear becomes very difficult if such a choice is made because of the high torque reaction on the case, the relatively low mass of the gear, and the low frequencies that are to be isolated.

Accessory Box

The problem of driving a full complement of accessible accessories from a turboprop or turbojet engine is not an easy one. For turbojets, we may see a separate accessory box driven from a power output pad with a shaft at right angles to the axis of the turbojet and located somewhere near the center of the machine. This method is not desirable for the turboprop engine if it incorporates an attached reduction gear and is mounted forward of the wing. Probably, therefore, turboprops will generally incorporate methods for driving a separate accessory box from the rear or from the side of the machine, as desired. If driven from the rear, the accessory box will, of necessity, be located some distance behind the engine to clear the exhaust system.

Lubrication System

The lubrication system is an important item affecting installation. The oil consumption of turbojet engines should be very low, so that the oil tank has been incorporated into the body of several

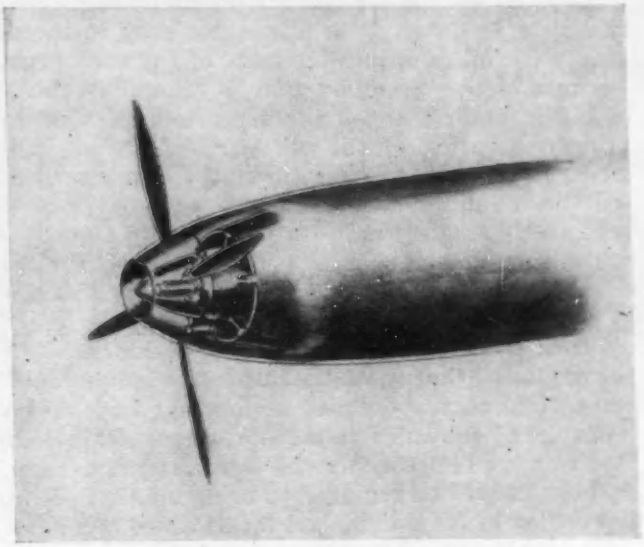


Fig. 3 – NACA Type E cowl for turboprop air inlet

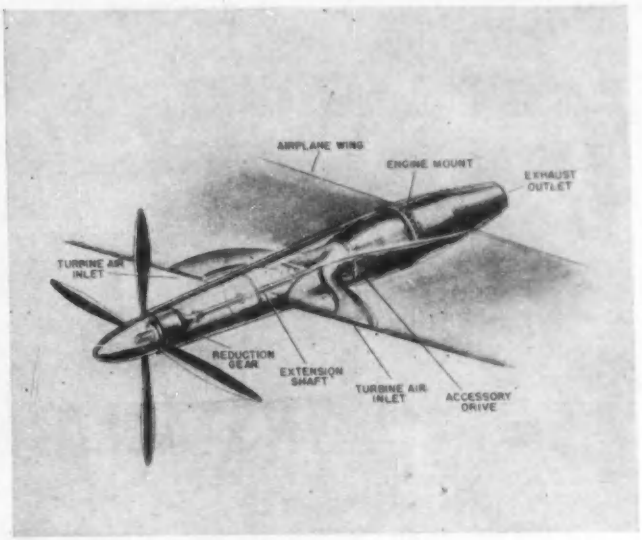


Fig. 4 – Typical air inlet using extension shaft to propeller reduction gear

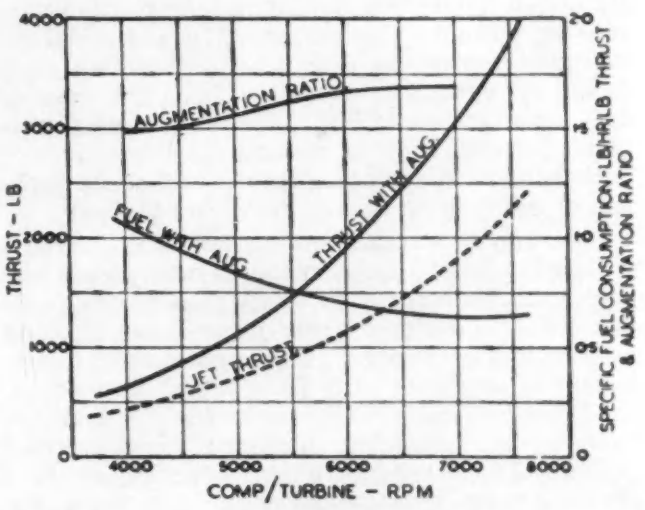


Fig. 5 – Relative performance of simple turbojet and turbojet combined with ducted fan

turbojets to date. It is also quite easy to incorporate the oil tank into the body of the turboprop. Because of the reduction gear, a greater quantity of oil is required to circulate per minute, and, to prevent aeration of the oil, particularly at high altitude, somewhat larger tanks than on turbojets will be required. To keep the quantity of oil reasonably small it may be necessary to incorporate special deaerating devices in the turboprop engine. They will also require oil coolers because of the heat rejection of the reduction gear. It appears most convenient to attach this item to the engine so that when the oil system is developed for satisfactory operation, it does not have to be redeveloped for a different installation. This does lead to some difficulty for the installation engineer because he will be required to bring an air duct to the cooler in its established location. It seems as if the majority of turboprops and turbojets will have complete integral lubrication systems.

Two developments show promise of considerable reduction in fuel consumption, namely, the use of a ducted fan on the turbojet and of regeneration on the turboprop. The Metropolitan Vickers Co. of England has built a turbojet engine with ducted fan. Fig. 5 indicates the performance of this unit with and without the ducted fan attachment. If we assume the specific consumption of a turboprop engine utilizing the simple gas turbine cycle as 100%, the consumption utilizing regeneration will be about 88%. This will vary with compression ratio and, at high compression ratios, regeneration becomes unattractive because the exhaust temperature is not sufficiently above the outlet temperature from the compressor. In any case, the regenerator presents a serious structural problem and would increase the weight of a simple machine by 70%. For very long-range work we will probably see regenerative machines after a considerable development period.

■

INSTALLATION FOIBLES

Continued from p. 52

attached to the transmission through its nose case, instead of from its normal mounting points to the rear or bottom. This imposes the additional requirement on engine designers of providing more mounting versatility than has been the case to date. Also shown in Fig. 2 are other main powerplant features such as cooling air inlets, ejector outlets, and fuel tank locations as well as the problem of submerging the engine within the body.

Submerged installations – powerplants located within the body – are common to most single and some multiple rotor craft. They pose quite a problem for the designer from a serviceability and accessibility standpoint. Unlike submerged installations in airplanes with nacelles and power eggs, the helicopter engine is buried in the body and surrounded by structural elements, firewalls, fuel tanks, and cooling ducts. Fireproof and fume-proof firewalls must separate the engine and passenger compartments and also enclose separate fuel tanks from the general engine exhaust areas.

With rotor loads applied near the body top and landing gear loads applied near the bottom, there must be continuity of structure between these two points. This structure has a remarkable affinity for blocking accessibility to engine installation innards.

From an access standpoint the powerplant area is most critical. Both power and rotor control must be fed into the rotating system in this zone. The designer must strategically place complicated control system mechanisms on engine top side so that they and powerplant components can be readily serviced and adjusted.

Submerging the engine in answer to demands for sleek styling and aerodynamic smoothness further complicates the designer's problems. Fig. 4 portrays what the designer is up against in powerplant installations. Crowded with fuel tanks and engine appendages such as carburetor air heaters, air filters, and auxiliary fuel pumps, this area takes on a "sardine-can" compactness.

Improvements in Turbojet Installations

FROM A PAPER* BY **R. E. SMALL**
Aircraft Gas Turbine Division, General Electric Co.

INSTALLATION of turbojets in aircraft is being refined as well as the powerplants themselves. Better mounting arrangements, cooling systems, and exhaust systems are resulting from the joint efforts of engine manufacturers and airframe builders to get the most out of the combination of their products.

Some of the improvements are already in use. Special fixtures have been developed to support the powerplant. In some installations, hottest sections of the engine are shrouded to prevent radiation and surrounded by bulkheads to keep fuel away in case of fuel-line failure. Exhaust pipes are being fitted to withstand both the axial load and the helical expansion.

Still in the experimental stage are variable-area jets to improve fuel economy and performance, and bleed-offs of heated air from compressor and turbine for deicing purposes.

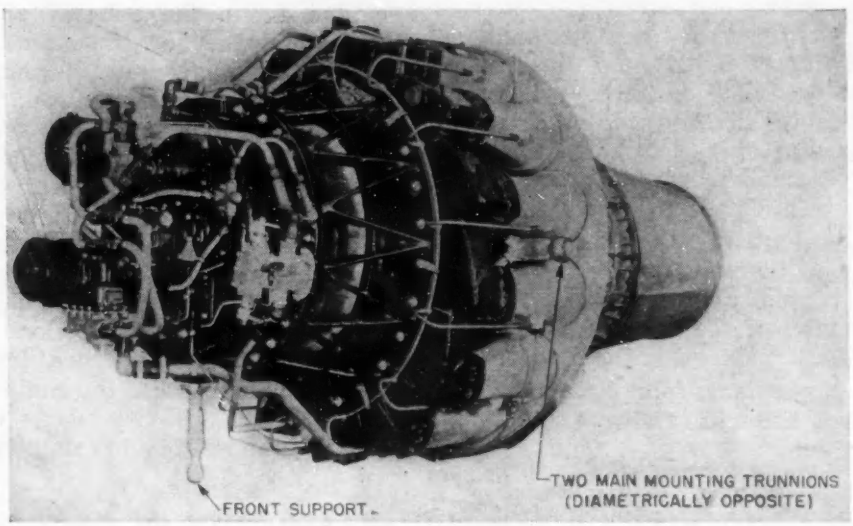


Fig. 1 – General Electric I-40 turbojet with its three-point mounting arrangement

New Mounts Developed

The turbojet mount should fulfill four basic requirements:

1. It must safely carry the weight, thrust, and gyroscopic load encountered during any condition of operation.

2. It must prevent loads due to contraction and

*Paper "Installation Engineering of Aircraft Turbojet Engines" was presented at SAE National Aeronautic Meeting, New York, April 11, 1947.

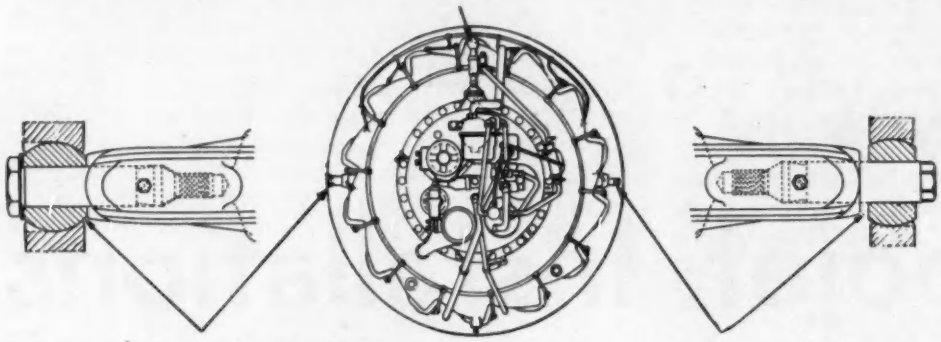


Fig. 2 – Typical spherical-bushing support for I-40 turbojet

expansion of the powerplant and to airplane structural deflection from being carried into the engine.

3. It should be as near as possible to the center of gravity of the turbine.

4. It should permit quick installation and removal of the engine.

To fulfill these requirements with the I-40 turbojet, General Electric designed a three-point mounting arrangement. Two main trunnions in the horizontal plane carry the principal loads. The third support is located either at the top or the bottom of the accessory gear case. Fig. 1 shows the arrangement.

Aircraft manufacturers are advised to provide spherical bushings on each of the main trunnion journals – one bushing to be fixed so that it cannot slide along the trunnion journal and the other bushing to be free to slide as contraction and expansion of the engine or structural deflection of the airframe may demand. Fig. 2 is a diagram of a typical spherical-bushing mount configuration.

This metal-to-metal mount has given very satisfactory service, but investigation showed that vibration might eventually cause fatigue failure. For this reason, many of the newer installations use some antivibration material in the mount.

On the TG-180 powerplant, four main trunnion pads are provided on the midframe at the aft end of the axial-flow compressor and four steady-support pads at the front end. Fig. 3 pictures this arrangement. In most installations, the engine is supported by the two horizontal main-trunnion pads at the midframe and by a third support at either the top or bottom pad at the front of the compressor. An alternate third-support location at the top of the turbine flange at the aft end of the combustion chambers is sometimes used.

Ejectors Used for Cooling

Several means have been employed to protect against the very high operating temperatures of the burner and turbine sections. Fig. 4 shows a turbojet with a complete shroud extending from the burner to the exhaust pipe. A cooling air ejector induces flow through the annular space between the engine and shroud. Fig. 5 shows a combination of shrouding and insulation. The shroud surrounds the combustion chamber only; and the turbine, exhaust cone, and exhaust pipe are blanketed in insulation. Again, the ejector is used to induce airflow for cooling.

The need for separating the hot regions around the burner and turbine from any leaking fuel has resulted in the use of a bulkhead at the forward end of the combustion section. In case of battle damage or fuel-line failure, leaking fuel cannot get by the bulkhead to the combustion and turbine sections.

Part of the bulkhead is supplied with the power-

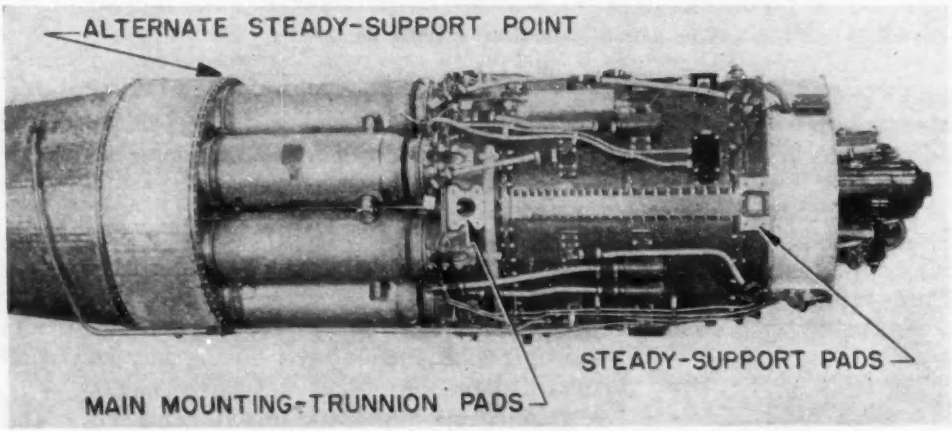


Fig. 3 – General Electric TG-180 turbojet with its mounting pads

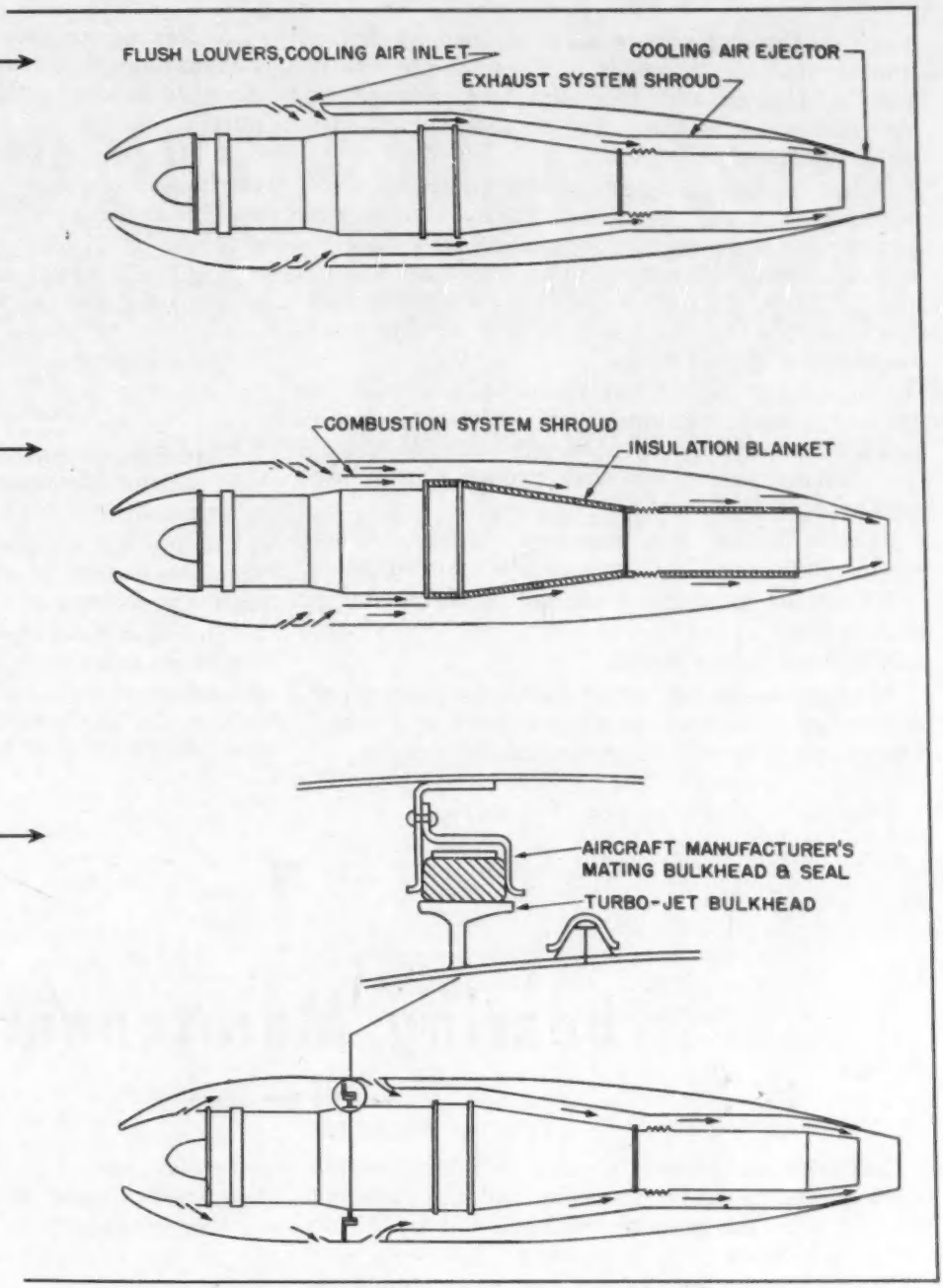


Fig. 4 – Turbojet installation with shroud extending from burner to exhaust pipe, and ejector for inducing cooling air

Fig. 5 – Turbojet installation with combination of shrouding and insulation, and cooling air ejector

Fig. 6 – Firewall bulkhead between compressor and turbine sections

plant and part is built into the airframe by the airframe manufacturer. The mating parts are illustrated in Fig. 6.

The addition of the bulkhead across the nacelle requires that cooling-air inlet louvers for the aft sections of the nacelle be located on the rear side of the bulkhead. Usually, a louver is also provided ahead of the bulkhead at the bottom of the nacelle for the discharge of ventilating air from the compressor section.

The complexity of the exhaust installation depends partly on the distance from the engine exhaust cone to the jet nozzle. There are few design problems if the jet nozzle is fastened directly to the end of the exhaust cone, or if only a short length of pipe connects the engine with the jet nozzle and the pipe is not supported from the airframe structure.

But, when the exhaust pipe is too long to cantilever from the engine, the pipe must be supported so that it has both axial and torsional freedom.

Axial freedom is needed so that no loads will result in the engine from slight changes in the axial dimensions of either the engine or the airframe structure supporting the exhaust pipe.

There are also torsional deflections to be accommodated without transmission of load. The exhaust gas temperature as measured around the inside of the pipe is not uniform for all conditions of engine speed or altitude. Also, there is a slight

swirl in the gas stream as it is discharged from the turbine. As a result of these conditions the exhaust pipe expands helically. During landing or severe maneuvers, there may be torsional deflection of the airframe structure.

Where an exhaust pipe is needed between engine exhaust cone and jet nozzle, engine-change time limitations and accessibility conditions dictate the use of a quick-disconnect joint between cone and pipe. The joint must be flexible enough to allow for tolerance in engine and aircraft structure and for structural deflection.

The advantages of variable-area jets with gas turbine powerplants having axial-flow compressors are becoming more and more apparent. With prop-jets, variable-area jets with properly integrated control should:

1. Give better fuel economy during cruising operation because high rpm can be maintained.
2. Provide more rapid change in thrust during acceleration.
3. Permit cooler starts.
4. Compensate for thrust variation among production engines, so that all turbojets in a multi-engine airplane will deliver equal thrust.
5. Permit maintenance of maximum allowable exhaust-gas temperature at full rpm, regardless of changes in compressor inlet temperature or pressure across the jet nozzle.
6. Compensate for variations among production engines – variations due to tolerances on blades and clearances – applied to a specific model of airplane.

Studies have shown that a variable-area nozzle will be required for most methods of thrust augmentation. Of course, the variable-area jet will add to the complexity of the installation.

Hot Gases Aid Deicing

Experiments have been made using hot gases bled off the compressor or the turbine to combat icing conditions on the wings and in the air intake.

Compressor air has proved more effective than turbine exhaust in deicing wings because of its higher pressure.

When gas from the turbine exit was mixed with intake air to warm it, some corrosion resulted from the action of exhaust gases. It was still necessary to heat the intake screen and the first stages of the compressor in order to get away from icing.

■

Bearing Maintenance

continued from page 49

Crankshaft alignment should be held to within 0.001 in. for the main journals, and the crankpin parallel with the main journals should be within 0.001 in. in 6 in.

Clearances for crankshaft and rods should be held to:

DIAMETER Inches	END CLEARANCE Inches
2 to 2¾	0.004 to 0.006
2¾ to 3½	0.006 to 0.008
3½ to 5	0.008 to 0.01
5 and over	0.01 to 0.012

Connecting rod bores should be checked as have been the main bearing bores. It is always desirable to have the out-of-round so that the horizontal is greater than the vertical diameter; a maximum taper of 0.005 in. is permissible.

Bore finishes as coarse as 80 microin. offer small support and the tolerance for taper parallelism should be held to 0.001 in. to 6 in.

Procedure for checking connecting rods with bearings in place is similar to that for the mains, and tolerances for out-of-round are the same. Clearances should be held to:

MATERIAL	RODS (Per Inch of Diameter) MIN.	RODS MAX.	MAINS MIN.	MAINS MAX.
Babbits: Tin, Lead & Cadmium base, and trimetal with cast or plated surfaces of 0.001 in. or thicker	0.0005	0.001	0.0005	0.00125
Copper Leads and Leaded Bronze	0.0075	0.0015	0.0075	0.00175

Three diameters of camshaft bores should be measured 120 deg apart, at front and rear of each bushing bore. These should not exceed 0.001 in. for out-of-round, taper and bell mouth. Clearances should be held to 0.005 in. per 1 in. diameter minimum, and not over 0.001 per in.

To insure freedom from dirt, nicks, scratches, and burrs, careful visual inspection is required in assembly. Generous use of 600W will tend to prevent scratches and help to align oil holes.

MARTIN 202 HYDRAULIC SYSTEM FEATURES SAFETY & EFFICIENCY

Combining 1500-and 3000-psi Systems Saves Weight, Increases Reliability

EXCERPTS FROM A PAPER* BY

T. C. HILL Controls and Hydraulics Design Engineer

and **E. G. RILEY** Chief, Mechanical Design Section

Glenn L. Martin Co.

THE hydraulic system of the Martin 202 offers major weight savings by using 3000 psi for the heavy loads of the flaps and landing gear in addition to allowing the use of past satisfactory service experience with 1500-psi units for brake valves, windshield wipers and steering. It further eliminates the need for the unknown variable volume pump. For the airline operator, this system places emphasis on reliability, reduced maintenance time and cost, quiet and smooth operation, and minimum possibility of external leakage.

Action of this system in normal flight is such as to maintain a continuous open-center flow through the 3000-psi circuit and at the same time to maintain automatically a margin of 1250 to 1500 psi in the closed-center circuit. This is accomplished by the combination of a modified Vickers 3000-lb unloading valve and a pressure reducing valve.

Unloading valve modifications consist of reducing the unloading range to 1250-psi cut-in and 1500-psi cut-out and the use of a separate pilot pressure line from the accumulator. The latter serves to produce the cut-in and cut-out signals in lieu of the normal pressure feed-back through the accumulator port. The pressure reducing valve is mounted in the accumulator line adjacent to the unloading valve and is set to reduce from 3000 psi to 1700 psi. This unit also incorporates an integral relief valve.

Fig. 1 shows a simplified diagram of the main pressure circuit. Landing gear and wing flaps are in the 3000-psi open-center circuit while nose wheel steering, windshield wipers and brakes are operated from the 1500 psi closed-center circuit.

This diagram illustrates the normal flight condition with the closed-center system charged to 1250 to 1500 psi and with the entire pump flow idling through the open center circuit. In this condition, the open-center system pressure is only approximately 300 psi as a result of normal pressure drop through lines and valves.

Unloading Valve Action

Fig. 2 shows the conditions existing when the unloading valve is in the "cut-in" position and the pumps are charging the closed-center system. This occurs whenever the system pressure drops below 1250 psi due to valve operation or internal system leakage. As the accumulator fills and the pressure increases to 1500 psi, the unloading valve is actuated to the "cut-out" or open-center position. The "cut-in" and "cut-out" pressure signals are transmitted directly to the unloading valve from the accumulator by a separate line.

When the landing gear valve is actuated, the conditions in Fig. 3 exist. Open-center flow is cut off at the landing gear valve and the pump flow is directed to the landing gear cylinders. The system pressure then builds up to that required to move the landing gear. It is here that the pressure reducing valve comes into action.

Assume that at the time the landing gear valve

*Paper "Design Features of the Martin 202 Hydraulic System," presented at SAE Aeronautic Meeting (Spring), April 11, 1947.

Landing Gear Valve Operation

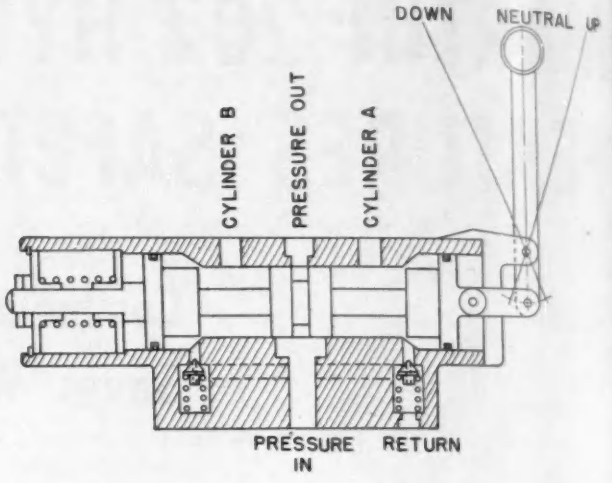
In the neutral position shown, pump flow enters the valve's pressure-in port, passes around the spool, and out the pressure-out port.

For automatic operation, the pilot moves the valve handle to the right or up position. The spool moves to the left against the action of the centering spring, admitting flow from the pressure-in port to cylinder port A. At the same time the pressure-out port is blocked and the opening to the right-hand return poppet is closed off.

Pressure builds up in the pump pressure line and starts raising the landing gears. Return flow from the cylinders enters cylinder port B, lifts the left-hand return poppet off its seat, and flows across the right-hand return chamber and out the return port.

When all gears are up and locked, return flow to port B stops and the return poppet reseats. The valve spool then returns to neutral position by centering spring action. The small amount of fluid displaced by the spool in returning to neutral passes to the return line through the small hole in the return poppet.

Moving the control handle to the left accomplishes the landing gear down cycle in the same way. The valve operates automatically from 16 gpm (take-off output) to ¾ gpm (emergency electric pump output).



is actuated, the closed-center system pressure is 1400 psi. As the system pressure builds up above 1400 psi, due to landing gear loads, the check valve in the unloading valve is opened and the pump flow splits, part going to the landing gear cylinders and part to the closed-center accumulator. As the accumulator fills and the pressure reaches 1700 psi, the pressure reducing valve shuts off and holds the closed-center pressure at that value.

The entire pump flow then goes to the landing gear cylinders to complete that operation, after which the landing gear valve automatically returns to the open-center position. The system is then back in the same condition illustrated by Fig. 1, except that the closed-center system pressure has been raised to 1700 psi. Wing flap operation results in a similar action in the pressure circuit.

An important functional feature of the system is the matter of priority of operation. The closed-center 1500 psi circuit has priority over the open-center circuit at all times; unloading valve and pressure reducing valve action directs pump flow to this system at any time when the pressure drops below 1250 psi.

This insures that windshield wipers will not be slowed up due to lowering flaps and landing gear during the approach. It also insures against loss or impairment of brakes, wipers, and steering due to raising or lowering flaps while taxiing. If the pressure required to operate flaps on the ground is less than 1250 psi and the closed-center system pressure drops to this figure, the unloading valve will momentarily cut in and stall the flaps until the closed-center pressure builds up to 1500 psi. At this point, the unloading valve will cut out and flap operation will be resumed.

In flight, the pressures required for flap and landing gear operation will be above 1250 psi. This automatically keeps the closed-center system fully charged and prevents any interruption of flap operation due to unloading valve cut-in. Continuity of operation of the landing gear cycle is assured in a similar manner.

Landing Gear Operation

With an open-center system, the landing gear handle must be latched in the neutral or mid-position at all times when the landing gear is not being actuated. In this position the pump flow passes straight through the valve and is blocked off from the cylinder ports. The cylinder ports are open to one another and the return port. This prevents any inadvertent build-up in pressure in the cylinders due to thermal expansion or leakage from the open-center pressure line.

To raise the landing gear, the handle is unlatched and raised to the up position. In this position the pump flow is directed to one side of the landing gear pistons, the return flow from the other side passing out through the valve return port. The landing gear handle must remain in the up position until the landing gear is up and locked, at which time the valve must be returned to the open-center or neutral position.

This handle operation must be entirely automatic once the pilot has moved the handle from the neutral to either the up or down position. This permits the pilot to concentrate on other duties while the landing gear is in motion. It also insures against his forgetting to return the handle to neutral after the operation is complete.

Return flow from the cylinders holds the valve in the operating position against the action of a

centering spring. When the return flow stops, signalling completion of the landing gear operation, the centering spring "takes over" and returns the valve to neutral. At left is a schematic diagram of the valve.

All landing gears retract up and forward against the airstream. For down operation, it is only necessary to furnish power to release the uplocks and the gears will go down and lock by action of gravity and airload. Since it only requires approximately 500 psi to release the uplocks, the system pressure in the down direction has been limited to 900 psi. This is accomplished by installing dual relief valves in the landing gear down line and results in an appreciable weight saving in the landing gear, support structure and cylinders. It also saves needless wear and tear on the pumps and system.

Mechanical Safety Device

In case of complete failure of the hydraulic system, a simple cable-operated mechanical uplock-release system is provided with a pull handle accessible to the crew. The normal landing gear control lever may be left in the neutral position when lowering the gear by means of the emergency uplock release.

Wing flaps are of the high lift double slotted type. The horizontal stabilizer is movable and is actuated only in conjunction with the flaps, automatically neutralizing flap pitching moments. The four wing flaps, fuselage flap, and stabilizer are each actuated by an irreversible screw-jack. A high speed torque tube system serves to drive and interconnect all screw-jacks.

Power to actuate the torque tube system is furnished by a centrally located power unit which mounts the flap actuating valve, hydraulic drive motor, control linkage, and mechanical limit stops. A manual hand crank is provided in the aft end of the fuselage to operate the flap system in case of hydraulic failure.

The flap control system incorporates prepositioning. With this feature, the flap angle is proportional to the flap handle position selected by the pilot. This is a highly desirable feature since, to select any angle of flap, the pilot merely moves the flap handle down to that position as marked on the cockpit control quadrant. The flap then moves down to the preselected position and stops automatically because the flap valve is returned to neutral by action of the follow-up mechanism.

Nose Wheel Steering

A power steering system is provided for a full 60-deg rotation of the nose wheel either side of neutral. This angle permits turning the airplane

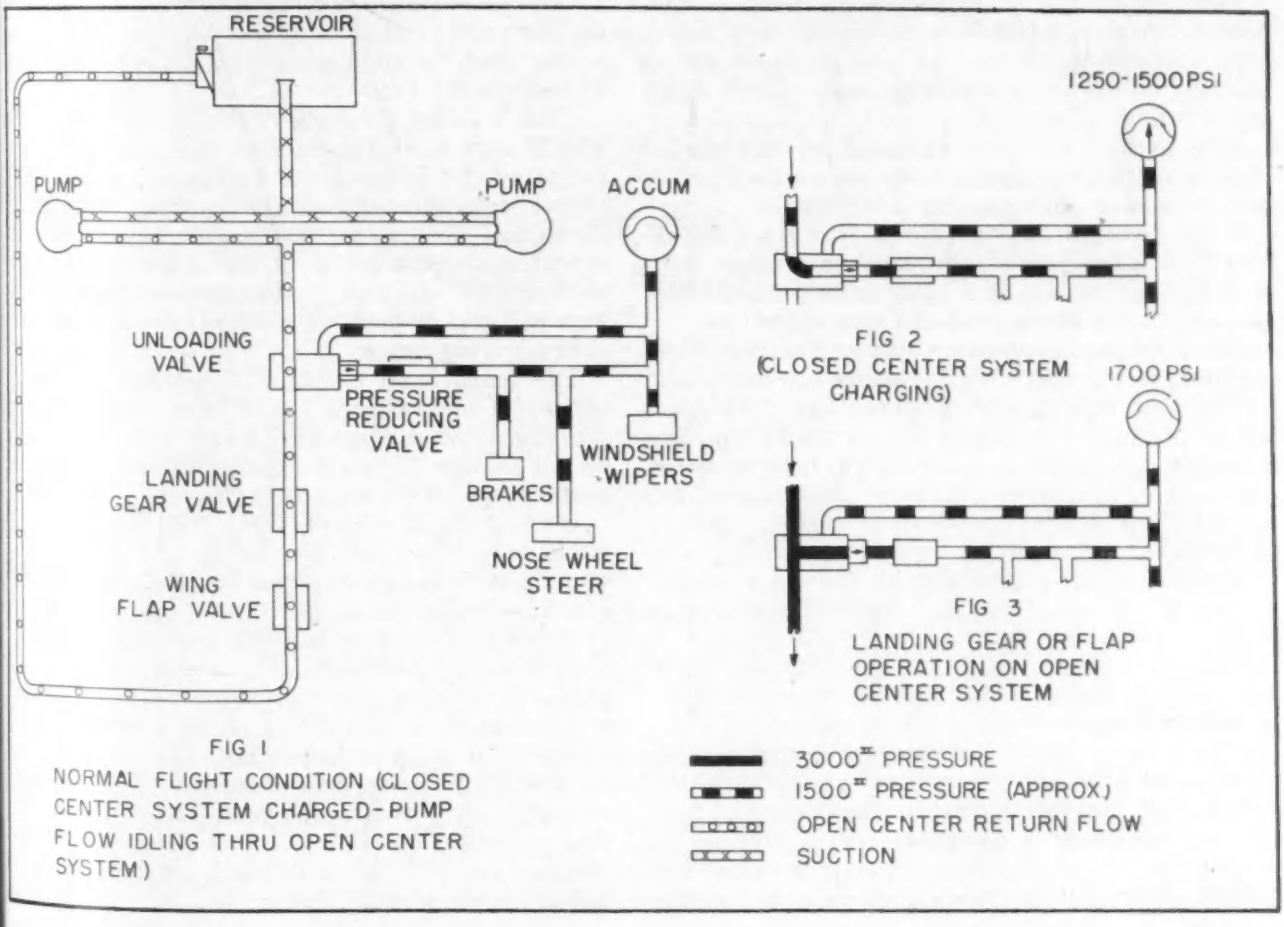


FIG 1
NORMAL FLIGHT CONDITION (CLOSED CENTER SYSTEM CHARGED-PUMP FLOW IDLING THRU OPEN CENTER SYSTEM)

FIG 2
(CLOSED CENTER SYSTEM CHARGING)

FIG 3
LANDING GEAR OR FLAP OPERATION ON OPEN CENTER SYSTEM

about either main gear for easy maneuvering in restricted areas. Steering is accomplished by a steer wheel mounted on the console to the left of the pilot and nose wheel movement is proportional to steer wheel movement. The nose wheel is shimmy damped at all times and is automatically free to caster when the pilot is not steering. Provisions are made to prevent steering when the nose wheel is not in contact with the ground.

Brakes

Normal braking action is accomplished by two single unit brake valves, one for the right wheels and one for the left wheels. Brakes are provided for both pilot and co-pilot by means of a mechanical linkage inter-connecting the brake pedals. Parking brakes are applied by a separate foot pedal to the left of the pilot's rudder pedals which depresses both brake valves simultaneously. Release of the parking brake is accomplished in the normal manner by depressing both brake pedals. Pressure for the normal brake system is supplied by the 1500 psi system accumulator.

A separate emergency brake system is provided. A single brake valve which is identical to the normal brake valves is used for this system. This valve is actuated by a hand lever on the left side of the pilot and applies brakes to all four wheels simultaneously through a separate line with shuttle valves at each wheel.

Pressure for the emergency brake valve is supplied from a separate 5-in. accumulator which is kept charged by normal system pressure, but is checked off so as to discharge only to the emergency brake valve.

Additional braking is provided by the use of reverse pitch propellers which can be used either as a normal or emergency braking means.

It can be seen that the objectives for a satisfactory hydraulic system for transport aircraft have been met by the use of a basic system design best adapted to the attainment of these objectives.

The 3000-psi open-center system has been used for those items where high pressure can be utilized to the best weight saving advantage. The open-center principle eliminates the necessity for continuously maintaining or storing this high pressure, resulting in increased reliability and reduced fire hazard. The 1500-psi closed-center system has been utilized for those items where no appreciable weight gain could be realized by the use of higher pressures and where stored hydraulic energy is necessary or desirable.

This two-system combination functions automatically in a simple and reliable manner for reduced maintenance cost to the operator.

The detail design of each system results in such features as automatic return to neutral, prepositioning flap control, automatic flap overload, and automatic conversion from castering to steering or vice versa. These features provide essential hydraulic services with minimum effort and attention required by the pilots at times when they are busy with other functions.

In case of failure of the normal hydraulic system in flight, at least two alternate methods of operation are available for each of the three services normally required for a safe landing. The landing gear may be lowered by the electric pump or by manual uplock release with automatic extension by gravity and airload. The flaps may be lowered by electric pump or manual hand crank. Braking is assured by the emergency brake system and reverse pitch propellers.

UTILIZATION OF FUELS

continued from page 35

to fuels produced by any of these refining processes further increase the octane number.

On the engine side of the balance are the pressure factor and the temperature factors. The pressure factor is compression ratio. The temperature factors are valve temperatures, piston temperatures, combustion chamber temperatures, inlet air temperatures, valve timing and spark advance. These temperature factors affect the temperature of the mixture at the time of ignition.

Any given fuel factors on the right side of the scales can be balanced by pressure and temperature factors on the left side. If the temperature factors are reduced, the compression ratio can be increased to balance the fuel.

This is just a progress report of the work General Motors Research has done over the 30 years including the postwar and up to the present time. It has demonstrated that, with proper attention to structural design, an automotive engine can be operated at compression ratios as high as 12.5 to 1 without any sacrifice in smoothness. Such an engine will give impressive gains in economy over the entire driving range.

The jump from 6.5 to 12.5 compression ratio cannot be made at once for various reasons. There are almost 30 million vehicles on the road which do not require higher octane gasolines. It will be many years before they are worn out.

While it would not be possible for the automobile industry to retool entirely to obtain the full advantage of 12.5 to 1 in any year, neither would it be possible for the oil industry to shift over to the production of high octane fuel over night.

In designing new engines it is possible to incorporate such factors, so that compression ratios can be increased in succeeding models without the necessity of complete retooling. Then, by increasing the compression ratio in step with the fuel, it will ultimately reach the maximum values. The changes can come as rapidly as automotive engineers and petroleum chemists learn how to commercialize the possibilities.

Seeks More Stable Helicopter Control By Moving C. G. Of Split Fuselage

Fig. 1 – This unorthodox helicopter model, being flight tested by its designer, is controlled by relative motion between its two-part fuselage. These model tests point to c.g. movement as a means to better hovering control and flight stability

Digest of paper

By CHARLES M. SEIBEL

Boeing Airplane Co

A HELICOPTER controlled by changing the c.g. of its split fuselage can give the control stability conventional rotary craft now lack, claims Seibel. He feels that a helicopter of this configuration can be produced and operated as economically as the modern light airplane and can be flown just as easily.

Standard helicopters are controlled by cyclic pitch changes. Varying the main rotor's lifting vector accomplishes lateral and longitudinal control. With the present arrangement, a small control misadjustment leads to rough control – stick shake – as well as vibrations in the machine.

Lack of significant forces on the controls provides no tendency for a return to trim condition after control motion away from it, as with an airplane. Pulsating control forces under some flight conditions tire and annoy the pilot. And "hands off" hovering flight is not possible.

These shortcomings of the present helicopter control system led to the belief that moving the c.g. instead of the lifting vector will provide good control without the usual undesirable characteristics.

To further study this possibility, a small flying model helicopter was constructed. It's shown in Fig. 1. The fuselage was built in two parts and interconnected by pin-ended links. One portion of the model fuselage was spring-loaded forward and restrained by a control cord. The model was suspended on an arm so that it was free to move vertically and horizontally, and rotate in the plane perpendicular to the arm.

Electric wires carried power along the arm to an electric motor in the model. The control cord traveled over a pulley at the model, parallel to the arm, and then over a series of pulleys to a control stick. Control stick motion causes relative motion between the two portions of the helicopter fuselage.

Successful flight test results with the model indicate that a full-scale helicopter with this simplified control system could be built.

Such a helicopter should be simpler in design and less costly to produce and maintain than present types. Proper fuselage design can replace stick "shake" with significant control "feel" by which the pilot evaluates the craft's stability.

It would allow a more efficient lifting rotor design, completely free of tiring control feed-back forces. (Paper "Stability and Control Characteristics of a Simplified Helicopter," was presented at SAE National Personal Aircraft Meeting, Wichita, May 2, 1947.)

■

Engine Supercharging "Headaches" Analyzed

Digest of paper

By R. L. WEIDER

White Motor Co.

(This paper will be published in full in SAE Quarterly Transactions)

BEFORE supercharging can be used to obtain maximum efficiency and economy in gasoline engines, the author warns, certain design problems must first be solved.

For instance, the author points out that it is necessary to decide whether to employ a Roots blower type or the centrifugal type. The author definitely favors the centrifugal, despite its present-day lower efficiency, for he feels that with design refinements it can be made just as efficient as the Roots type. He explains that the centrifugal supercharger has such advantages as:

1. It is less critical to speed ratio of supercharger to engine.

2. It is easier to match the torque output requirements of the engine to the centrifugal.

3. There are greater possibilities for standardization in production and modernization of existing equipment, for it permits the use of the same components in so far as transmission, drive line, and rear end assemblies are concerned, as with the normally aspirated engine.

4. It is easier to adapt the centrifugal design to the engine.

Other difficulties arising in the adaptation of superchargers to engines are discussed by the author, such as:

1. The engine block, connecting-rod and main bearings, pistons, rings, and head gaskets must be able to withstand the higher outputs and temperatures.

2. All temperatures in the combustion chamber must be kept uniform so that one phase will not influence the predetermined flame propagation.

3. Oil temperature must be kept low enough to prevent oil deterioration.

4. Distributor and carburetor must operate at predetermined curves with great accuracy.

5. Radiator capacity must be increased to handle higher outputs.

6. Fuels must not produce excessive deposits in induction systems and combustion chambers.

7. Spark plugs must operate without fouling or preignition.

8. Underhood temperatures must be kept within reason. (Paper entitled "Some Problems Incurred Supercharging Gasoline Engines" was presented at SAE Annual Meeting, Detroit, Jan. 7, 1947.)

Supercharged Diesel Nets Economy Gains

Digest of paper

By C. R. JONES

Cooper-Bessemer Corp

TROUBLES usually associated with supercharged diesels are largely fictitious, declares Jones. He says that an engine properly designed for supercharging will not only operate as well as atmospheric engines, but will realize fuel economies well worth the cost of the supercharger.

One unfounded fear is that supercharging diesels increases temperatures. Believers of this misconception point out that their valve troubles are bad enough now and that they want no part of anything that will increase maintenance. But as a matter of fact, exhaust temperatures are actually lower in a properly designed supercharged engine so that exhaust valves actually give better service.

While pressures in the supercharged cylinder are slightly higher, they are not as high as most people think they are. This may call for larger bearings. And since pressure in the stroke is maintained longer in the stroke, more heat must be dissipated. This calls for oil-cooled pistons and more circulating water.

What supercharging does offer is more horsepower for a given engine package. Just how much more power you can squeeze out of any one engine without shortening its life depends on design of the equipment and method of charging. You just can't mount a supercharger on an engine and expect a 30 to 50% increase in output. Practically every part of the engine must be redesigned for supercharging to do the job right. Providing for higher pressures is an example.

Exhaust-driven turbochargers are more practical for larger units than the blower types because they don't require power to drive them and are more flexible.

The exhaust-driven supercharger is a simple device consisting of a turbine arrangement through which the exhaust gases pass. This directly drives an impeller resembling a centrifugal pump impeller.

Speed of this impeller varies with engine requirements which are taken care of automatically. As you feed the engine more fuel, exhaust gas becomes denser. This turns the turbine over faster so that more air is pumped and scavenging is increased. A multiple-pipe exhaust manifold is the key to proper scavenging.

Both this and the blower type of supercharging cut fuel consumption considerably – especially at light engine loads. Supercharged engine efficiency is 5% higher than that of an atmospheric engine at full load and much higher at light load. With fuel costs rising, such savings are becoming increasingly important.

Many of the headaches engineers encountered in supercharger development have been licked. Today there are engines supercharged between 30 and 40% running 24 hr per day, month in and month out, that appear to live as well or better than atmospheric engines. (Paper "Diesel Engine Supercharging," presented at SAE Northwest Section, Seattle, March 3, 1947.)

Improved Seal Devised For Hydraulic Systems

Digest of paper

By DAVID R. PEARL

Hamilton Standard Propellers Division

(This paper will be published in full in SAE Quarterly Transactions)

SEALING of the operating fluid in high-pressure hydraulic systems can now be accomplished satisfactorily with the aid of a synthetic rubber ring of special design, called the O-ring seal, which fits in a groove in the piston so that when the piston is inserted in the cylinder the seal is slightly compressed between the wall of the cylinder and the bottom of the seal groove.

According to the author these seals are effective, dependable, and economical for both static and moving seal applications, and if molded of super-synthetic rubbers, can be successfully used with fluid pressures up to 5000 psi. He claims further that by proper use of these seals, hydraulic mechanisms can often be made smaller, simpler, and lighter without sacrificing their desirable features.

The paper discusses the theoretical aspects of O-ring seal operation and outlines a detailed design procedure, including charts and formulas for determining seal material, piston-cylinder clearance, seal and groove dimensions, and seal friction. (Paper entitled "O-Ring Seals in the Design of Hydraulic Mechanisms" was presented at SAE Annual Meeting, Detroit, Jan. 7, 1947.)

Design Factors

Digest of paper

by W. E. THILL

Federal-Mogul Corp.

WHETHER a bearing is better produced by the tubing method or the faster strip process depends on factors such as steel thickness, bearing size, and flange thickness, Thill says. By way of example, he explains that:

The tubing method, more popular of the two, consists of lining steel tubes or bronze full-round casting with the desired alloy. The strip process is responsible for higher volume production of uniform quality bearings. It consists of moving a long steel strip, about

Fig. 1 – Bearings produced by the tubing method are babbitted by this centrifugal casting machine

6 in. wide, through a mill that applies the lining material to the steel.

Tin-base and high-lead babbitt bearings can be made by either method. Permissible steel thickness limits use of the strip process in some instances.

High-lead babbitt bearings usually are made by the tubing method. A 6-in. length of steel tube of proper diameter and wall thickness is fluxed, tinned, and inserted into a babbitting or centrifugal casting machine, like the one in Fig. 1.

The tube OD is then snagged, cut to required bearing length, and machined.

By the strip process, a steel strip is babbitted in a machine as shown in Fig. 2. From this blanks are cut to proper length and formed in a "U" shape, and then converted by machining into a half bearing.

Tubing processing of copper-lead bearings is done in one of two ways. Molten copper-lead can be spun into

Rule Bearing Fabrication

tubes – similar to high-lead babbitt technique. Or the lining material can be gravity-poured into a specially-constructed steel part, as shown in Fig. 3. Here the outer steel shell eventually becomes the bearing back.

Both processes require careful quenching control to solidify the copper-lead instantaneously.

Copper-lead can be applied to steel strip in a molten state or in powder form. Using a combination copper and lead alloy powder is becoming increasingly popular. Desired physical bond and other properties are obtained by rolling and sintering or roasting.

Advantage of powder metallurgy in bearing making is the thorough blending of the powder mixture prior to application. It produces a uniform final product, conducive to good bearing performance.

Powder quality plays an important part in final product quality. The freer the powders are of copper and lead oxides, the better adherence and the closer contact of each powder particle with its neighbor.

Silver linings are electrolytically applied to tubing. Strip steel is processed by rolling the bi-metal strip.

No specific rules govern the process by which each bearing type should be produced. Each bearing is a problem unto itself. Table 1 – which gives some clues – is a listing that reflects the opinion of four bearing production experts on the approximate 1947 bearing output in this country. The percentages represent the proportion in number of pieces of that type as against the total number of bearings that will be used in reciprocating machines – engines or compressors.

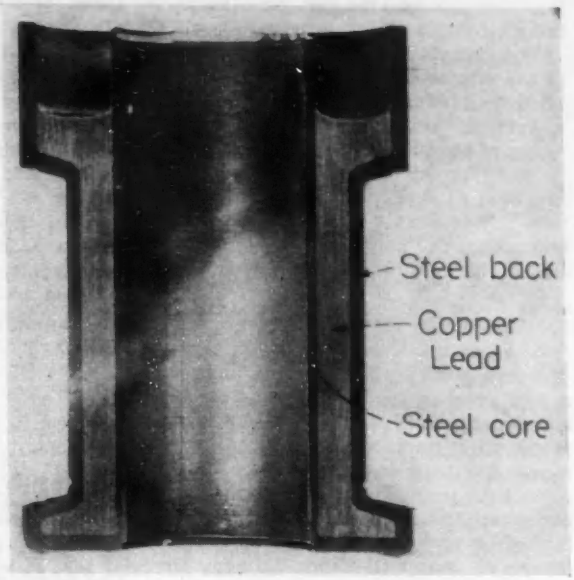


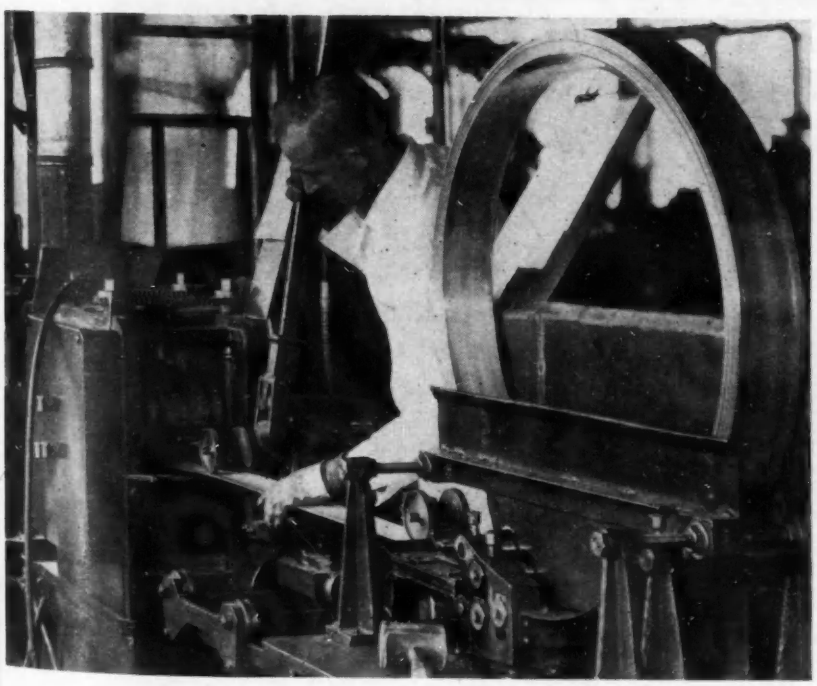
Fig. 3 – This kind of tubing-process copper-lead bearing is made by gravity-pouring the lining material in this steel form

Table 1 – Projected 1947 Production of Sleeve Bearings by Materials

Lining Materials	Tubing	Strip
Tin base babbitts	5%	10%
High lead babbitts	6%	54%
Cadmium alloys	4%	2%
Copper alloys	1%	4%
Copper alloys – overplated	2%	10%
Aluminum alloys	1%	1%
Silver	—	—
Silver – overplated	Negligible	Negligible

While the tubing method is somewhat slower and thus slightly costlier, both are equal in end result. (Paper "Sleeve Bearing Lining Materials," presented at SAE National Transportation Meeting, Chicago, April 18, 1947.)

Fig. 2 – In the strip process of bearing making, this machine babbitts the steel bearing backing



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Ignition Analyzer Uses Oscilloscope

Digest of paper

By H. C. WELCH and J. V. McNULTY

Bendix Aviation Corp.

A PORTABLE, light-weight electronic ignition analyzer has been developed for use on aircraft internal-combustion engines. In their paper on the analyzer, Welch and McNulty explain:

Malfunctioning of the ignition system is detected by observing changes in primary-voltage waveforms shown on the screen of a cathode-ray tube. An impulse from one particular spark plug is used to trigger the horizontal sweep circuit so that the first pip on the left of the screen corresponds to the cylinder from whose spark plug the impulse

was taken, and pips for the other cylinders follow in firing order.

The signals from the primary circuit of the magneto being analyzed are supplied by means of a tandem switch to a vertical amplifier and the vertical plates of the tube. The signals from the primary circuit of the other magneto are used to supply the constant-amplitude sweep circuit. The tandem switch transposes the primary circuits so that either magneto may be analyzed.

Detects Numerous Troubles

Some of the conditions which can be detected and identified by the analyzer are: a short in the high-tension circuit, insufficient voltage to break down the spark-plug gap, an open circuit primary due to insulated contact points or a broken primary connection, and excessive arcing at the breaker points caused by an open circuit primary condenser or heavy oil vapor between the points.

The analyzer itself weighs 23 lb. Total weight of a flight installation for checking all engines of a four-engine plane is 37 lb. Only one analyzer is needed regardless of the number of engines per plane or the number of cylinders per engine. The analyzer can be attached in a few minutes to any high-tension or low-tension ignition system. (Paper "Ignition Analyzer for Internal-Combustion Engines," presented at SAE Annual Meeting, Jan. 9, 1947.)

Revenue and Comfort Of Trucks on Upswing

Digest of paper

By E. S. ROSS

Peterbilt Motors

FUTURE heavy-duty trucks will be designed to relieve driver fatigue and to carry maximum payload by using light-weight alloys, Ross predicts.

He says that truck designers are eyeing devices to diminish some of the physical labor of truck driving. Possibilities are that automatic transmissions may be adopted for commercial vehicles. Already some buses and off-the-highway trucks have hydraulic steering.

This can be done with a hydraulic gear alone or with boosters connected to the front-axle tie rod or to the drag link. Equipping heavy-duty on-highway trucks with hydraulic steering would go a long way toward making the driver's chore easier.

Another driver aid is a movement on foot by the American Trucking Associations to locate instruments in standard positions on the instrument panel. Of equal importance is ATA's attempt to standardize shifting patterns for all transmissions. This would allow transfer of a driver from one vehicle to another without the hazards of operating an unfamiliar vehicle.

Cutting vehicle tare weight to make room for more payload is possible by building aluminum fenders, hoods, stepboards, and skirts. A 50% saving in weight can be realized over a similar part in iron or steel. An aluminum dual axle now in production is said to be some 400 to 500 lb lighter than its steel and malleable counterpart.

Aluminum brakes on these axles are both lighter and more powerful because of increased brake area.

Transmission housings in both unit power and auxiliary units are available in aluminum. They're capable of handling torque output of the largest engines with a weight saving of from 146 to 195 lb. Aluminum steering gear housings – also available – are 20 lb lighter.

These aluminum parts can be designed with the strength of their steel and iron predecessors. (Paper, "Heavy-Duty Trucks – Present and Future," presented at SAE Southern California Section, Los Angeles, Jan. 16, 1947.)

More Aircraft Electrical Uses Breed System Selection Dilemma

Digest of Paper

By E. P. BUCKTHAL

United Air Lines, Inc.

FLEXIBILITY and reliability are furthering the trend toward increased use of electrical energy for aircraft auxiliary power, Buckthal claims. But these greater electrical loads are generating controversies over what constitutes the most efficient type of system.

Lists Electrical Merits

Engineers favor electrical over hydraulic and mechanical systems, he points out, for these five reasons:

1. The electrical system is flexible since power can be delivered to remote points with a minimum of installation problems.

2. Electrical energy can be applied universally for all auxiliary power uses.

3. The system is clean, containing no fluids – as in hydraulic systems – that may leak.

4. Short period overloads as high as 200% are permissible with electrical power as opposed to such restrictions using hydraulic or mechanical equipment. Electrical systems can take intermittent or momentary overloads without requiring increased weight of the primary system.

5. Adding electrical capacity costs little in weight since parasites such as mounting brackets and generator frame are not chargeable to that account. Weight per kilowatt decreases very rapidly with increase in capacity.

But in their zeal to keep electrical systems light in weight, engineers are cautioned to preserve their reliability. Many instruments vital to aircraft operation are electrically driven and electrical failure invites trouble.

One way of protecting against circuit mishaps is to build systems with both high overload capacity and with several power sources in parallel. With this arrangement, failure of one source will not materially deplete the system's power-producing ability.

Controversy Over Types

The evolution of airplane electrical systems, brought about by increased loads, has come to an important crossroads. Designers are debating over which fork in the road to take. Shall it be AC or DC, constant frequency or variable frequency power?

The conventional 28v DC system offers some advantages; but its disadvantages are swiftly overcoming its merits. Many favor the 28v DC system because it offers:

a. Parallel operation without need for exact speed synchronism;

b. An available storage method;

c. Use of the airplane structure as a ground return;

d. DC motor torque-speed characteristics adaptable to many airplane applications.

But high voltage DC is becoming less flexible and adaptable because of bulky switch gear, faulty high-altitude operation, reduced voltage starting of motors, and increasingly difficult design of both motor and generator commutators.

In large air transports, answer to these problems appears to be high voltage three-phase AC systems operating at 400 cycles. One trouble here is the difficulty in obtaining constant frequency power. Designers are now hoping to hurdle this obstacle by developing either (1) alternators delivering constant frequency regardless of rotor speed, (2) a trouble-free constant-speed drive, or (3) a reliable auxiliary powerplant.

A contrary school of thought advises that 60 to 80% of airplane electrical loads may be powered directly from a high-voltage variable frequency source. Only 20 to 40% need be converted or transformed – much less than with constant frequency power.

The opposition points out the difficulty of providing parallel operation with variable frequency power. But this is not beyond solution. Propellers are now being built with micro-sensitive speed adjustments; electrical elements that sense speed variations control engine speed. One engine acts as a master to which all other engines are slaved, providing perfect engine synchronism.

Agreement among engineers extends only to the need for higher voltages to supply increasing electrical loads. Differences among these claims favoring DC against AC and variable against fixed frequency must be reconciled in SAE type technical committees. (Paper "Electrical Power and the Transport Airplane," was presented at SAE National Aeronautic Meeting (Spring), New York, April 9, 1947.)

Scores Service Merit Of Rubber-Sprung Bus

Digest of paper

By W. R. HUBKA

Twin Coach Co.

RUBBER springing the new Twin Coaches on the Torsilastic suspension will reduce maintenance and produce a passenger car-like ride, Hubka believes. His reasons are as follows:

1. No bearings to lubricate or service;

2. No abrasion, rust or wearing action from dirt, water, or mud;

3. No squeaks or rattles;

4. Clean, lightweight, and simple design;

5. Eliminates friction, reduces vibration;

6. Long service life;

7. Absorbs shock or impact from all directions;

8. Reduces noise level – no metal-to-metal contact with axles;

9. No danger of sudden failure as with leaf or coil springs;

10. Provides soft, elastic ride. Rubber acts as bearing to reduce harshness;

11. Suspends entire chassis in a rubber cushion;

12. Resistance to roll or sway is greater than with any other suspension of the same spring rate. Shackle installation reduces coach tendency to tip on a curve at high speed.

13. Minimum floor height change between empty and loaded conditions, and

14. About a 20% weight-saving realized. It's doubly important since this weight is normally unsprung. (Paper "Torsilastic Motor Coach Suspension," presented at SAE British-Columbia Group, Vancouver, Dec. 12, 1946.)

Coming Car Engine Ignition Detailed

Digest of paper

By H. L. HARTZELL

Delco-Remy Division
General Motors Corp.

HIGHER compression ratio engines will demand increased secondary voltage from car ignition systems, Hartzell states. He says it can be met in these three ways:

1. Present 6-v System:

If we stick to 6-v electrical systems, use of a two-coil, four-lobe cam combination will probably be necessary for a 9 or 10 to 1 compression ratio. Tests show that each full ratio increase will require an 8% rise in plug voltage.

2. Going to 12-v System:

Switching to a 12-v system would permit retention of the present single-coil and eight-lobe cam combination. In fact, it will give more margin at top speed on the 10 to 1 ratio than there is now with the 6-v system on the 6.5 to 1 ratio engine.

A 12-v system would pay dividends even on present-day cars. Fig. 1 shows the advantage with low-resistance plugs. With a 9 kv requirement at 60 mph, the 6-v system will miss at 1 megohm leakage resistance; the 12-v system will operate until plug resistance drops to 0.3 megohm.

This will permit many leaky plugs to clean up and operate for many more miles without becoming troublesome.

The present system will handle the 10 to 1 compression ratio engine if the engine designer complies with certain minor requirements. He will have to mount the coil near the distributor. Leads to plugs must be short. Larger condensers and reversing switches will improve low-speed performance.

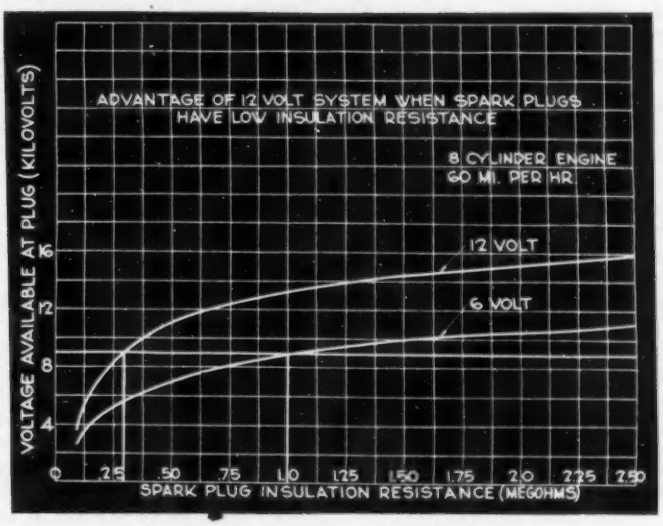
3. Adopting Electronic System:

An electronic system will deliver even more voltage than the present type. While it will boost costs, its advantages might be worth the increase.

Voltage will not be affected by low-resistance plugs. Energy will be delivered to the secondary system at ten times the rate of the present system. Enlarging component sizes will increase voltage. This isn't the case with present systems.

Increasing the size of present coils may even reduce the output. And larger contacts will not carry any more current without oxidizing. (Paper "Ignition Progress," was presented at SAE Milwaukee Section, Dec. 10, 1946.)

Fig. 1 – With a 12-v instead of a 6-v ignition system, leaky spark plugs would last longer since minimum plug insulation resistance is higher for the 6-v system



Diesel Wear Related To % Sulfur in Fuel

Digest of paper

By C. C. MOORE and W. L. KENT

Union Oil Co. of Calif.

A STUDY of the effects of sulfur, nitrogen, and naphthenic acid on the rate of wear in diesel engines showed that wear increases markedly with increasing sulfur content but that nitrogen and naphthenic-acid contents have no noticeable effect. From their study, Moore and Kent report that:

Diesel fuel containing 0.7% sulfur may cause four or five times as much wear as fuel with zero sulfur content. Sulfur as it occurs in the fuel and sulfur in the form of thiophene added to low-sulfur fuels had about the same effect when the sulfur concentrations were equal.

Tests were run with coolant temperatures of 100 and 160 F. With both low-sulfur and high-sulfur fuels, wear was several times greater at the lower temperature.

It appears that there are two corrosive actions: the action of the sulfur and the action of the carbonic acid formed by condensation of moisture in the presence of carbon dioxide. (The coolant temperature of 100 F would permit condensation, but the higher temperature would not.)

Further tests with various lubricating oils showed that it is possible to compound an oil which will combat the sulfur content of the fuel. One such oil used with a fuel containing sulfur reduced wear to 27% of that occurring when commercial heavy-duty lubricating oil was used.

In all of these tests, wear was measured by the increase in the iron content of used crankcase oil. A sample of oil was drawn from the crankcase and ashed. The iron was dissolved in hydrochloric acid and reduced to the ferrous ion with hydroxylamine. The addition of o-phenanthroline solution caused the formation of a colored complex ion. The amount of iron present was determined by measuring the intensity of the color with a spectrophotometer. Results with this chemical method of measuring wear agreed well with physical-measurement data obtained later from an engine manufacturer's tests on the effect of the sulfur content of fuel.

Success of chemical wear measurement hinges on two precautions – (1) taking samples for iron analysis that are perfectly representative of oil in the crankcase and (2) using an analytical method that's accurate for small amounts of iron.

First requirement is met by sampling oil from the oil gallery directly into the crucibles in which the sample is to be ashed. Use of recently developed photoelectric colorimeters for iron analysis will satisfy the second must.

By taking these precautions, this method will measure small wear rates more accurately than actual measurement of the worn parts. (Paper "Effects of Nitrogen and Sulfur Content of Fuels on Rate of Wear in Diesel Engines," presented at SAE Annual Meeting, Jan. 10, 1947.)

Outlines New Method Of Valve Cam Design

Digest of paper

By WINSTON M. DUDLEY

Case School of Applied Science and Thompson Products, Inc.

A NEW method of calculating valve cam profiles brings the actual pattern of valve motion closer to the desired pattern by taking into account the flexibility in the valve linkage. Discussing this analytic method and its advantages, Dudley says:

When records of actual valve motion were superposed on theoretical valve motion as determined by cam profile, the two did not coincide. It was reasoned that the conventional cam-design process failed because it assumes complete rigidity, ignoring the deflections which occur in the valve linkage.

A new process was developed which does not ignore the deflections. First the desired valve motion is specified. Then calculations are made to lay out a cam profile which, acting through the valve linkage and at the design speed, will cause the desired motion to take place. The method seeks to minimize acceleration.

A number of cams for use in aircraft engines and automobile engines have been designed by this new method. Their superior performance, when used with constant-clearance mechanisms, has proved the value of the method.

With variable clearance, the constant cam lift-valve motion relation assumed in the design process is not maintained throughout the range of operating conditions, and it is impossible to correct the cam design fully. It is probably not worthwhile to apply the process unless some self-adjusting mechanism is used to stabilize clearances.

The analysis on which the method is based brought out a theorem the textbooks have missed: Eccentricity of the point of contact of cam and tappet is proportional to the velocity of lift.

It has been found that much of the routine calculation can be done on punch-card accounting machines. A typical cam profile requiring lift values calculated at 70 to 80 points, can be computed in three hours or less. The results arrive in tabulated form printed automatically by the machines. (Paper "New Methods in Valve Cam Design," presented at SAE National Aeronautic (Spring) Meeting, on April 10, 1947.)

Shop-Wise Plane

Digest of paper

By W. A. DAVIDSON, P. H. PELLEY, R. E. SAUNDERS, and J. W. RIX

Beech Aircraft Corp.

DOVETAILING manufacturing "horse sense" into airplane design saves dollars in time and material, Davidson, Pelley, Saunders, and Rix show.

All too often, they point out, a part is designed as a forging when it could more economically be extruded. And many times a part is specified as an extrusion or seamless tube when it could be made more cheaply from sheet stock formed to required shape.

Arguments that the designer's work schedule prohibits careful consideration of materials alibi the shirking of one of his prime responsibilities.

Shop Ignorance Decried

One in one hundred designers has a thorough knowledge of production methods. The other ninety nine would be embarrassed if asked to explain why the fabricating processes they call for in drawings are most economical. Small wonder that hordes of requests for drawing changes "to facilitate production" pour into the engineering department even while the production line is starting.

But most important cost consideration is not the material nor production methods. "Is it necessary?" is what the designer should ask himself when considering a new part. Obvious way to cut cost of a part is to eliminate the part itself. It also saves the expense of attaching it to adjacent parts.

This overall saving must be matched against a possible cost increase due to manufacturing complexity of the remaining parts.

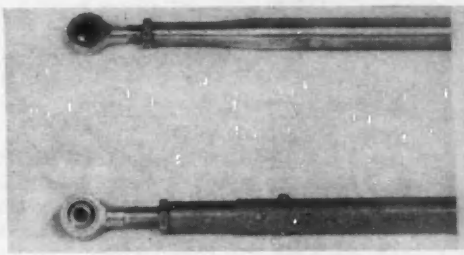
Rewards of Good Design

Not only do these preachings sound well, they work. Tooling and manufacturing costs can be reduced at no sacrifice in that all-inclusive factor called quality. Results from practicing this policy in design of a current model in production at Beech are proof of its efficacy.

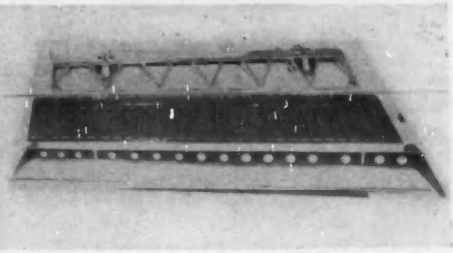
Table 1 demonstrates the economies brought about in a redesign of the stabilizer alone. The savings are typical of those in assemblies such as the rear seat frame, front carry-through structure, and elevator and trim tab.

The illustrations offer visual evidence of the dividends aggressive challenging of existing designs can pay.

Design Yields Lighter, Less Costly Product

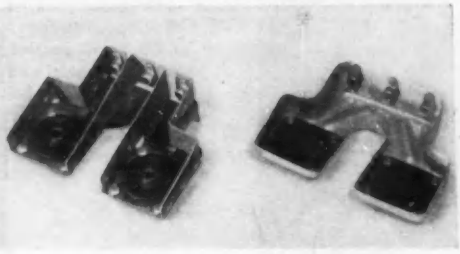


The original push-pull tube, below, had a machined end riveted in place. The simplified part was produced by swaging a tube over a mandrel, simultaneously thickening the wall and forming threads



Above the line is the original wing flap and below is the modified one. Using magnesium in the thinnest available gages made the flap lighter and considerably stronger than the first version

Nearly 60 linear in. of gas welding was eliminated by design simplification of the carburetor main and alternate air duct and valve assembly (top)



Modifying the original shock mount design, shown at left, resulted in the stamping at right that replaced four parts and made a lighter, stronger unit

This airplane's designers maintain they've improved, not reduced quality. In many instances weight has been saved, none added. Light-gage structures have been replaced with heavier gages, less susceptible to vibration and fatigue. And the designers feel airframe maintenance has been reduced.

In just ten items of the type discussed, 65 hr and 50.34 min per airplane were saved in manufacturing time. Multiplying total per plane savings by a yearly production quantity of 2000 airplanes shows a saving of 131,678 man-hours.

Experience on this job showed that the many years of complex structural design have instilled great resistance to change in most individuals. But once the simplification concept makes inroads in an engineering department, it becomes contagious.

Today the aircraft industry is in the position of the prisoner of long ago. After many years behind the bars, he one day leaned on the door to his cell and found it unlocked. It had always been unlocked. The way to freedom had always been his. And the way to improved aircraft at lower cost has always been the industry's. (Paper "The Relationship of Aircraft Design to Tooling and Manufacturing Costs," presented at SAE National Personal Aircraft Meeting, Wichita, May 1, 1947.)

Table 1 – Savings Realized in Redesigning an Airplane Stabilizer

	Original Design	New Design
Fabrication, assembly and installation per ship	24 hr, 45.06 min	8 hr, 3.92 min
Material cost per ship	$15.45	$11.18
Total tooling time	5876 man-hours	2477 man-hours
Number of parts per ship	86	28
Weight per ship	27.04 lb	20.10 lb

Car Engine in Planes Is Erratic Performer

Digest of paper

By JOSEPH C. FUNK

Funk Aircraft Co.

POWERING light planes with modified automotive engines invites unreliability and other troubles, Funk found after several years of such work. He feels that both low price and high reliability of today's standard small plane engines overshadow any gains hoped for using car powerplants.

After three years of experimentation in the late 1930's, his company succeeded in building a small engine from modified parts of a Ford Model B, 4-cyl engine. Production cost including radiator and installation accessories

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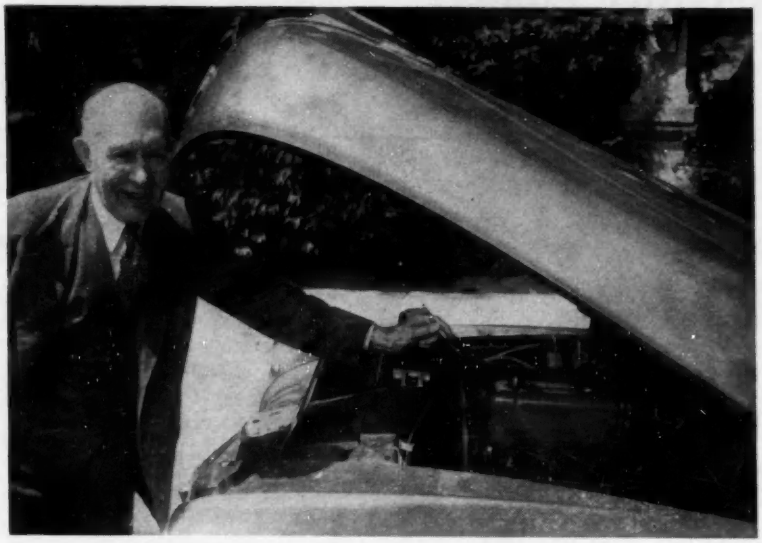
About



CHARLES F. KETTERING on June 3 retired as GMC's vice-president in charge of research laboratories and announced in an SAE talk completion of a 12.5 compression ratio engine operating on "semi-commercial" fuel. "Ket" will continue to serve General Motors as a director and consultant. President of SAE in 1918, he was honor guest at an informal dinner at French Lick on June 4 attended by all of the SAE past presidents who attended the Summer Meeting.

JAMES M. CRAWFORD, also an SAE Past-President, becomes GM vice-president in charge of engineering in a shift of responsibilities stemming from Kettering's retirement which takes C. L. McCUEN from that post to Kettering's position as vice-president in charge of research laboratories.

ARNOLD V. PILLING, who had been with Wright Aero Ltd. as a field engineer, has been transferred to Wright Aeronautical Corp. in Wood-Ridge, because Wright Aero Ltd. has been dissolved. His position and duties remain the same, but his activities will be world wide.

No longer associated with the Hammond Aviation Co., Davenport, N. Y., **CHARLES W. HAMMOND** is assistant chief engineer at the Atlantic Division of the Pacific Airmotive Corp., Linden, N. J.

S. HILLARY WILLIAMS recently became affiliated with the Minneapolis-Honeywell Reg. Co. in Milwaukee.

Until recently connected with the Skwellman Co., Cleveland, **J. R. NURNEY** has become secretary-treasurer of the Precise Metal Products Co., also Cleveland.

Recently transferred from the Engineering Department of the Los Angeles office of General Electric Co., **AUSTIN G. SILVESTER** is in the Marine & Aeronautics Division, Aircraft Gas Turbine Section at Schenectady, N. Y.

LAWRENCE S. MARTZ has left the Micromatic Hone Corp., Detroit, where he was assistant to the president, to become account executive at Marvin Hahn – Advertising, same city. During 1946-47 he was assistant vice-chairman of the Production Activity in the Detroit Section.

ARTHUR W. BULL has recently been appointed chief engineer at Michigan Wire Cloth Co. in Detroit. He was previously a project engineer at King-Seeley Corp., Ann Arbor, Mich. Concurrently Michigan Wire Cloth Co. announced the establishment of a Research & Development Department with Bull in charge.

RALPH H. MOYERS has assumed the position of service superintendent at Kapiolani Motors Ltd., Honolulu. Prior to this he was with the Department of Interior, Surplus Property Office, also Honolulu.

No longer affiliated with the S. K. Wellman Co. at Cleveland, successively as sales engineer, branch manager, district manager, and original equipment representative, **WILLIAM H. WEISS** has been appointed fleet sales engineer for the Automotive Replacement Division at the Thermoid Co., Trenton, N. J.

Having relinquished his position as vice-president and assistant manager at the Southwest Grease & Oil Co., Wichita, Kans., **PAUL E. SUTORIS** is now one of two partners of the Wichita Steel Building Co., a new business.

CARY A. SARLO is now an inspection engineer with the Standard Oil Co. of Indiana in Whiting, Ind.

Now regional manager at the National Supply Co., Superior Engine Division, Fort Worth, Tex., **ALBERT B. REESE, JR.,** was assistant chief engineer at the same company in Springfield, Ohio.

Previously with the International Business Machine Corp. in Poughkeepsie, N. Y., **BERTON A. PURDY** is now a magneto design engineer with Gale Products, a Division of Outboard, Marine & Mfg. Co., Inc., in Galesburg, Ill.

Members

THOMAS F. BRUDENELL has become a shop engineer in the Producing Department at the Standard Oil Co. of California, Taft, Calif. Heretofore he was a design engineer with the Atlas Imperial Diesel Engine Co., Oakland, Calif.

Previously an assistant professor at the Case School of Applied Science, Cleveland, **ARTHUR P. FRAAS** is an associate in motors at the Aeronautical Institute of Technology of Brazil, Rio de Janeiro.

ALVIN B. COPELAND, who is no longer associated with the Bendix Products Division as a project engineer, is sales representative at the Andrews Distributing Co., Inc., South Bend, Ind.

EMORY N. KEMLER has relinquished his position as head of the Engineering Research Division, Southern Research Institute, Birmingham, Ala., to accept a post at New York University, New York City.

A sales and service engineer at the Motor Master Products Corp., Chicago, **MAURI ROSE** had been with the Studebaker Corp. in South Bend. Rose, who has an interest in auto racing, is winner of the 1941 Indianapolis 580 mile race and was national champion AAA Racing for 1936. He has been racing AAA Speedways for 20 years.

No longer a staff engineer at the Caterpillar Tractor Co., Peoria, Ill., **GEORGE H. GEARHART** is a sales engineer with the Robison Machinery Co. at Salt Lake City.

The Canadian Car & Foundry Co., Ltd., recently announced the appointment of **JOHN J. HOUSE** as general service manager of the Bus Division, with headquarters at the head office in Montreal. He had been employed with the Great Lakes Greyhound as a representative at General Motors Corp. in Pontiac, Mich.

EDMUND GEORGE PINGER, until recently with the American Car & Foundry Co., Berwick, Pa. as a design draftsman, is now affiliated with the Catalytic Construction Co., Philadelphia.

CHARLES A. CHAYNE, Buick's chief engineer, is president of the Veteran Motor Car Club of America. He has just announced that the 1947 Glidden Tour of antique automobiles will be held in New England. Abandoned in 1913, the Tour was reinstated last year by enthusiastic antique automobile fanciers. More than 100 cars, built before 1915 but still in good running order, will start the run in Hartford, Conn.

At the annual meeting of the board of directors of the White Motor Co. held recently, **ALFRED D. EDGERTON,** secretary of the Engineering Department, was made assistant secretary of the company. He served the White Motor Co. as resident patent counsel until 1944 when he was made secretary of engineering.

JOHN G. CRAWFORD has become transportation and garage foreman with the Douglas Oil Co. in Clearwater, Calif. Prior to this appointment, he was field engineer, Fabor Laboratories, Los Angeles. Crawford has served on the Membership Committee of the Southern California Section for 1945, 1946, and 1947.

STEPHEN SCOTT has resigned his position as wholesale manager of the Kansas City branch of the Mack-International Motor Truck Corp., to work for the Mack distributor, the Fenner Tubbs Co., located in Lubbock, Tex.

Recently becoming assistant to the chief of the Rotor Group at the Piasecki Helicopter Corp., Sharon Hill, Pa., **JOSEPH RZECZYCKI** was design engineer for the Jet Helicopter Corp. in New York City.

E. E. ENSIGN, of the Ford Motor Co., was one of several speakers at the third annual spring meeting of the Metal Powder Association held at the Waldorf-Astoria Hotel in New York City. He described successful methods Ford Motor Co. have used to develop new low-cost tools, incorporating a new idea concerning the function of the core rod in the sizing operation and the use of an extrusion plate through which a part formed from powered iron is sized externally.

Until recently with the Wright Aeronautical Corp. in Woodridge, N. J., **JOHN M. BARSTOW** has been appointed sales engineer for the Walter G. Barstow Co. in Minneapolis.

STANLEY R. THOMAS has retired as chief engineer of the Torrington Co., Bantam Division, South Bend, Ind.

P. W. LITCHFIELD, chairman of the board, Goodyear Tire & Rubber Co., Akron, Ohio, left by plane recently from La Guardia Field for Uitenhage, South Africa, where he formally opened Goodyear's new factory on June 16. He was accompanied by three other Goodyear officials, one of whom was **H. L. GINAVEN,** assistant to the production manager. Goodyear's Uitenhage factory is said to be one of the rubber industry's most modern manufacturing plants outside the U. S.

NEW DEPARTURE PROMOTIONS

MARSCHNER STONER BANINGER COBB

Since 1928, treasurer of the Detroit Section, F. W. MARSCHNER has been appointed executive assistant to the general manager of New Departure Division, General Motors Corp., with offices at the Main Plant in Bristol, Conn. SETH H. STONER, acting divisional chief engineer of the New Departure Division, in the absence of T. C. DELAVAL-CROW because of illness, has announced that JOHN H. BANNINGER is reappointed assistant chief engineer and LELAND D. COBB is made manager of Research and Development.

SAE Fathers and Sons . . . . .

JAMES D. MOONEY, left, who has been an SAE member since 1920, and his son, **JAMES D. MOONEY, JR.,** M '45. The father is president and chairman of the board at Willys-Overland Motors, Inc., Toledo, Ohio. His son is president of Auto Engine Works, Inc. in St. Paul, Minn.

If any SAE reader knows of any SAE Father-and-Son combination, both of whom are members of the Society, your editors would appreciate hearing from you. Several SAE members have two Member-Sons.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated – we don't want to miss any SAE Father and Son grouping.

A. E. ZIMMERMAN is partner in the Zimmerman Engineering Co., Cleveland, which is just starting in business. His son, **MERRITT A. ZIMMERMAN,** is doing research work and is a partner of that company. He is also a partner of the Guerin-Zimmerman Co.

President and general manager of the Morse Chain Co. in Detroit, **FRANK M. HAWLEY,** left, with his son, **MYRON HAWLEY,** who is also with the Morse concern, serving as production engineer. Dad is an Old Timer with Morse, having joined the company in 1916. He has been an SAE member since 1923.

GEORGE C. CARHART, a member since 1917, is a consulting engineer in San Gabriel, Calif. Previously he was with the Detroit Diesel Engine Division of General Motors Corp. His son, **W. H. CARHART,** recently joined the Western Gear Works as sales engineer. He graduated from Syracuse University in 1929 and joined the SAE in 1938.

No longer associated with the J O Mfg. Co., South Gate, Calif., **RALPH C. FLUGEL** is now a design engineer at Consolidated-Vultee Aircraft Corp., Downey, Calif.

H. KENNETH HAY has become a liaison engineer at the Kelley-Koett Mfg. Co., Covington, Ky. Previous to that post he was a mechanical engineer, Bendix Aviation Corp., South Bend, Ind.

Recently becoming connected with the Lavers Engineering Co., in Chicago, as an engineer, **LOREN E. LURA** had been an experimental engineer, Graham Paige Motors Corp., Willow Run, Mich.

RANDOLPH J. ROSHIRT has been appointed general manufacturing manager of the Bohn Aluminum & Brass Corp. He will have charge of all manufacturing in the corporation's 14 plants. Roshirt has been associated with the Bohn organization since 1919.

Previously with the Bendix Westinghouse Automotive Air Brake Co., Atlanta, Ga., **LT. COL. HERBERT F. FARMER** is now chief of the Highway & Materials Handling Branch of the Transportation Corps Board, U. S. Army. He is stationed at the New York Port of Embarkation in Brooklyn, N. Y.

Now a partner in the firm of Sanderson & Porter, New York City, **PHILIP B. TAYLOR** had been with the Taylor Turbine Corp., same city.

DR. EDWARD WARNER was recently elected president of the Council of the International Civil Aviation Organization. He had served as president of the Interim Council of the Provisional International Civil Aviation Organization, predecessor to the ICAO. He is a past-president of SAE.

The opening of a new Wico Electric Co. sales office in Milwaukee has been announced by **H. M. SAUERS,** vice-president in charge of sales.

REYNOLDS M. GARRETT, who had been office manager of the Transportation Department of Johns Manville Sales Corp. in New York City, is now a salesman in the Automotive Equipment Section in Detroit.

Until recently a consulting engineer at the Northwest Engineering Co., Green Bay, Wis., **JOHN H. HOLLOWAY** has become chief engineer, Murphy Diesel Co., Milwaukee.

Preceding his appointment as assistant chief engineer for the Chicago Bumper Co., Division of Houdaille-Hershey Corp., **JOHN R. HERRON** was connected with the Oliver Corp. in South Bend, Ind.

BRUCE F. GRIMM, JR. is now chief of design, Engine Division, G. M. Giannini Co., Inc., Pasadena, Calif. Prior to this he was project engineer at the same company.

NEW EATON VICE-PRESIDENTS

R. H. DAISLEY was recently elected vice-president and director of manufacturing at the Eaton Mfg. Co., Cleveland. He joined the company in 1922, and has been general manager of the Wilcox-Rich Division, with offices in Detroit, since 1936. He became a director of the company in 1941. H. J. McGINN has been elected vice-president and director of sales at the company, as announced recently. McGinn, who joined the firm in 1913, has been general manager of the company's Reliance Division. He became a director in 1932.

B. F. SOUTH, who is no longer the merchandising manager of Pontiac Motor Division in Memphis, is vice-president of the Randall-South Motor Co., Fort Smith, Ark.

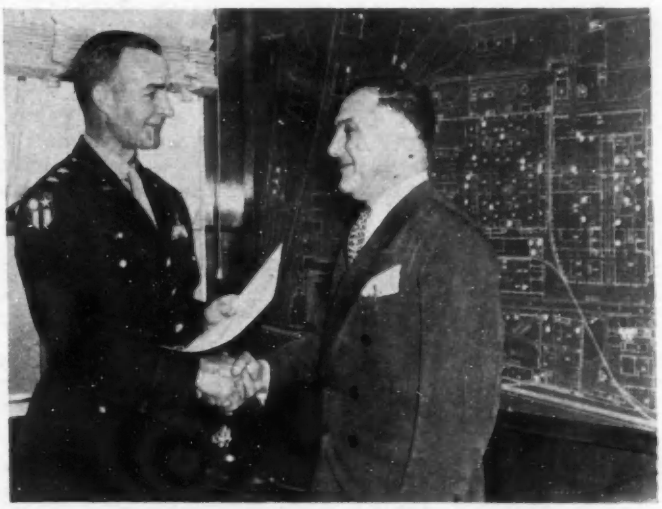
Now connected with the American Machine & Foundry Co., Cheektowaga, N. Y., as a machine designer, **GERHARD G. THIEM** had been a design engineer, Fredric Flader, Inc., Tonawanda, N. Y.

TIMOTHY E. COLVIN has been elected president of the Besler Corp. in Emeryville, Calif. He joined Besler early this year as executive vice-president, after having served for a number of years as president of Aerco Corp., Transamerica subsidiary.

No longer with the Busch-Sulzer Bros. Diesel Engine Co. of St. Louis, Mo., **HENRY A. ENGLISH** is presently employed by the Nordberg Mfg. Co. of Milwaukee, serving in the capacity of service and erecting engineer in the Heavy Machinery Division.

No longer a designer with the Caterpillar Tractor Co., Peoria, Ill., **PAUL E. HAISS** has become a diesel and vibration consultant in Alliance, Ohio.

Heretofore with the Goodyear Aircraft Corp., Akron, Ohio, as section head of the Research Department, **STUART C. PLUMMER** is a director of the General Development Corp., Elkton, Md.



ALEXANDER KARTVELI, right, designer of the P-84 and other Republic Aircraft planes, received a special award from the War Department in appreciation of his war work. Major-Gen. Charles B. Stone, III, chief of staff of the Air Defense Command, is presenting the award. Kartveli is vice-president and chief engineer of Republic Aviation Corp., Farmingdale, L. I., N. Y.

GEORGE E. WINTERS, a Continental Motors employee since 1918, was elected executive vice-president at a recent directors' meeting. In recent years Winters has served as vice-president and assistant to the president.

F. M. FALGE, sales executive for General Electric Lamp Department at Nela Park, Cleveland, has been promoted to the position of assistant manager of the department's Pacific Sales District, San Francisco. He joined General Electric as a lighting sales engineer for the Lamp Department in 1926.

EDWARD GRAY is now staff assistant to the chief of quality control and chief inspector at the White Motor Co. in Cleveland. He will assist, in advisory capacity, in supervising and planning the operation of the Inspection Department and the Quality Control Division. Previously he was works manager at the Watervliet Arsenal, Watervliet, N. Y.

ROBERT J. MARBLE has joined the Truck Equipment Co., Inc., of Buffalo, N. Y., as assistant to the president and general manager. In the past he has served in executive positions with many truck manufacturing companies in New England. Marble is field editor and chairman of the Publicity Committee of the Buffalo Section.

WILLIAM H. CROUSE has been appointed trades and industrial editor of the School Department at McGraw-Hill Book Co., New York City. Prior to this appointment, he was director of field service education, Delco-Remy Division of General Motors Corp., Anderson, Ind. He is the author of several books.

W. B. LIVINGSTON, a veteran in the bus manufacturing and sales field, has joined the Ford Motor Co. to head its bus operations. He will make his headquarters at the company's central office in Dearborn. Until he resigned recently, Livingston served as executive assistant to the general manager at the GMC Truck & Coach Division of General Motors Corp.

WILSON H. MORIARTY, vice-president of the National Malleable & Steel Castings Co., Cleveland, was recently elected president of the Malleable Founders Society for the coming year at the foundry society's 50th anniversary meeting held in Hot Springs, Va.

Recently resigning his position as vice-president of Lockheed Aircraft Service, Inc., a subsidiary of Lockheed Aircraft Corp., **REAGAN STUNKEL** was elected to the board and named president of the Aviation Maintenance Corp., Van Nuys, Calif. Stunkel has been actively associated with aviation maintenance for the last 20 years.

Formerly a staff engineer in the Research Department at the Caterpillar Tractor Co., Peoria, Ill., **ROGER M. SMITH** has now been appointed supervisor of the proving ground for new products at Phoenix, Ariz. for the same company.

Graduating recently from Washington State College, Pullman, Wash., **COY E. LOVE** has obtained the position of mechanical engineer with the Albina Engine & Machine Works, Inc., Portland, Oreg.

ARTHUR SHEPHERD HUKIN recently became an assistant engineer for the Lake Copais Co., Ltd. in Aliartos, Greece. Prior to this, he was a technical assistant with the London Passenger Transport Board in London.

No longer associated with the Armour Research Foundation in Chicago, Ill. as supervisor of mechanical design, **J. GREGORY GREEN** has become a research engineer, Fairbanks-Morse & Co., same city.

Stevens Institute of Technology, Hoboken, N. J., recently conferred an honorary degree of Doctor of Engineering on **HARRY T. WOOLSON,** who was graduated from there in 1897. He is vice-president of the Marine Division of the Chrysler Corp. and president of Chrysler Institute of Engineering, Detroit, having retired recently as executive engineer of Chrysler Corp. He served as SAE president in 1937.

DR. STEPHEN J. ZAND has accepted the appointment as vice-president in charge of engineering at the Lord Mfg. Co. in Erie, Pa. Prior to his new connection Zand was for 15 years with the Sperry Gyroscope Co. as senior project engineer. A member of the SAE since 1928, he is a Wright Brothers Medalist 1931 and was vice-president of the Society in 1941.

Photo By Leonard Victor

A. R. CODE has been appointed general manager of Silentbloc, Ltd., now located in London, England. During the war, he was controller of Armoured Fighting Vehicles Production in the Ministry of Munitions, Australia.

ERNEST R. BREECH, executive vice-president of Ford Motor Co. of Dearborn, has been elected to the board of directors of Ford Motor of Canada, Ltd. He is a member of the SAE Finance Committee.

WALTER E. SCHMIDT, for the past 17 years an employee in the Chevrolet engineering department, has been appointed resident engineer at the new Chevrolet-Flint assembly plant, as announced recently by **JOHN G. WOOD,** Chevrolet chief engineer.

WILLIAM LEE GRAY is now affiliated with the Boeing Aircraft Co. in Seattle, Wash. Formerly he was stress project engineer at the Boeing Airplane Co., Wichita. During 1946-47 he was a member of the Executive Committee and Membership Committee of the Wichita Section.

HAROLD F. HAMMOND has been appointed assistant manager of the Transportation & Communication Department of the Chamber of Commerce of the United States. He comes to the Chamber from the American Transit Association, for which he has been Washington Representative since 1944.

Having been a project engineer with the Jack & Heintz Precision Industries, Inc., Bedford, Ohio, **EDMUND BRUCE COOPER, JR.,** has recently accepted the position of chassis contact engineer with the Dodge Truck Plant, Division of Chrysler Corp. in Detroit.

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OBITUARIES

KARL M. WISE

Karl M. Wise died on June 6 at his home near South Bend, Ind., following a heart attack. He had attended the opening days of the SAE Summer Meeting at French Lick.

An SAE Past Vice-President of Passenger Car Engineering, he had continued active in SAE interests even after his retirement as director of engineering of Bendix Products Division, Bendix Aviation Corp. more than a year ago.

He held important positions in the automotive industry for many years. He came to Bendix following a number of years as vice president in charge of engineering of Pierce-Arrow. Earlier he had held responsible engineering posts with Studebaker Corp., Crucible Steel Co., and the old Chalmers Motor Car Co.

Aged 61 at the time of his death, he was a graduate M.E. of University of Michigan, and had joined SAE in 1919.

G. W. WALLACE, after serving for more than 10 years as chief chemist in charge of Developmental & Refinery Laboratories, was recently advanced to the position of superintendent in charge of the Freedom Refinery at the Freedom-Valvoline Oil Co., Franklin, Pa. Wallace is a licensed pilot and an avid enthusiast of aviation.

WALTER A. OLEN, president of the Four Wheel Drive Auto Co., Clintonville, Wis., has been named Wisconsin vice-president of the National St. Lawrence Association. Olen has long been an advocate for the completion of the canal and lock facilities in order to expedite the shipment of Wis. and midwest manufactured items directly from Great Lakes ports to seaboard cities and foreign countries.

BENJAMIN B. CRAVENS has been elected to the post of vice-president in charge of sales at the Franklin Machine Co., East Providence, R. I. He is well known in both automotive and aviation circles for his work in advancing time and labor economy through crew co-ordination. He was formerly executive vice-president of the Waymoth Corp., Pawtucket, R. I.

CARROLL H. VAN HARTESVELDT has become vice-president of Thompson Vita-Meter Corp. in Cleveland. Prior to this he was assistant to the manager of the Research Development Department at the Atlantic Refining Co. in Philadelphia. He was treasurer of the Philadelphia Section in 1945 and secretary in 1946.

WILLIAM H. HEERMANCE has resigned as chief engineer of the Empire Tractor Corp. (where he designed and built a small two plow agricultural tractor) to start his own engineering and development company under the name of Aero Acres in Schwenksville, Pa. Aero Acres is now developing an agricultural tractor of radical design.

ALBERT OLSON, who has been a member of the SAE since 1931, is now engineering assistant to the managing director of General Steel Wares, Ltd., Toronto, London and Montreal. He graduated from the Case School of Applied Science and served as general manager of the Dill Mfg. Co. of Canada, Ltd., Toronto, for 17 years.

WILLIAM JAMES GAUGH has become an aerodynamicist at Northrop Aircraft, Inc. in Hawthorne, Calif. Previous to this, he was an instructor of aerodynamics at Texas A & M College, College Station, Tex.

SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
WEST COAST T&M	Aug. 21-22	Biltmore Los Angeles
TRACTOR	Sept. 17-18	Schroeder Milwaukee
AERONAUTIC (Autumn)	Oct. 2-4	Biltmore Los Angeles
PRODUCTION	Oct. 20-21	Carter Cleveland
FUELS & LUBRICANTS	Nov. 6-7	The Mayo Tulsa
AIR TRANSPORT	Dec. 1-3	Continental Kansas City, Mo.
ANNUAL	Jan. 12-16 (1948)	Book-Cadillac Detroit

Student Branch News

Massachusetts Institute of Technology

Diesel engines are our most versatile prime mover, Prof. C. F. Taylor told M.I.T.'s May 14 Student Branch meeting. They range in horsepower from 10-10,000, and in displacement from 50-50,000 cu. in per cyl, and cheap fuel keeps them the most economical heat engines. But disadvantages slow their entry into many potential fields.

Diesels, Taylor said, are handicapped by:

1. High development cost;
2. High-cost injection equipment, often as expensive as a complete gasoline engine of equal power;
3. Abnormal tendency to develop carbon deposits and oil sludge;
4. Inability to burn solid fuels;
5. Weight that precludes aircraft use.

He believes the gas turbine is the diesel's most serious competitor at present, especially in railroad use. There is no competition from steam because of steam's narrow scope; there is little danger from gasoline engines, because fuel cost is so important in diesel applications.

Taylor's talk concluded with a moving picture taken at 40,000 frames per sec, showing flame travel in the combustion chamber of a test engine. The film demonstrated the effect on combustion of varying the time of fuel injection. Ignition takes place at top dead center, and combustion becomes more rapid as fuel injection is advanced because, at advanced positions, vaporization and fuel distribution are more complete. If the advance of injection is too great, however, combustion becomes almost instantaneous and knock results.

Lawrence Institute of Technology

Dr. G. P. Brewington, head of the Physics Department at Lawrence Institute of Technology, spoke to L.I.T. Student Branch members at their May 5 meeting on "Atomic Energy."

Brewington explained construction of the atom, named parts and described their characteristics, then explained two methods of releasing energy from the atom.

The first method, called synthesis, is a combining of simple atoms to form heavier, more complex atoms. In this process, the one from which the sun derives its energy, the resulting, more complex, atom weighs less than the total weight of its constituents. This loss of mass is called the mass defect; the lost mass has been released as energy.

Brewington pointed out that many of the lighter elements are suited to the synthetic process. Many show large mass defects that would produce large amounts of atomic energy if released. The synthetic process is the basis of the proposed hydrogen atomic bomb.

Second method of releasing atomic energy is the division of a heavy atom into less complex structures. In this process the sum of the masses of the resulting products is less than the mass of the original atom; the difference in mass is again released as energy. This is the method used in atomic bombs to date.

The speaker supplemented his talk with slides and two motion pictures: one the Encyclopedia Britannica film "Atomic Energy," the other a March of Time film on "Atomic Power."

He discussed the possibility of using atomic energy for industrial applications and proposed methods of using atomic piles as sources of heat energy. He also traced the history of nuclear physics and its progress from Einstein's experiments in 1905 to the present day.

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On May 6, L.I.T. Student Branch members took part in a dinner meeting at the Rackham Memorial Building in Detroit; meeting was a joint project of Detroit Section and the Student Branches in the Detroit area.

Speaker was Bill Stout, who demonstrated his well-known "Geflopigator" to add proof to his contention that thought, rather than equipment or laboratories, is the key to engineering and scientific advancement.

Stout urged engineers and students to develop their ideas even though they are handicapped by limited facilities. He encouraged the use of thought as an engineering tool, and pointed out the necessity for correct approach to a problem if best results are to be obtained.

During his lecture he showed two motion pictures: "One Second in the Life of a Hummingbird," a slow motion study of the wing action of a hummingbird in hovering flight, and "Aeronautical Oddities," an Army Air Force film made from a collection of news reel pictures demonstrating some of the "screwball" flying machines that have been invented. Stout's comment was "I wonder why they always show this picture on my program."

Students and Section members shared the same tables, as the meeting was called for the purpose of allowing students an opportunity to speak to engineers in various industries, and providing engineers with a chance to gage the caliber of present engineering students. After dinner, each Student Branch chairman reviewed the activities of his school branch.

Elliott showed slides emphasizing the importance of correct ignition-timing if high-compression engines are to give maximum power and fuel economy, and also the NACA film taken at the rate

of 40,000 frames per sec to compare burning rates of normal combustion and of detonation. – by Leon Warne, Field Editor.

Northrop Aeronautical Institute

Need for antiknock fuels for light engines of increased power was emphasized by Frank Elliott, fleet engineer of Ethyl Corp., at the May 21 meeting of the Northrop Student Branch.

Elliott told students that all grades of gasoline except 100 octane contain 19,000 Btu per lb. But when they are used in low-compression engines, only 7% of this energy is available as power; remainder is lost in the cooling system, in exhaust gases, and in friction of the engine parts.

When compression ratio of 3.5 to 1 is raised to 9 to 1, there is an increase in power of 33% and a decrease in fuel consumption of 33%. However, when low-octane fuels are used in high-compression engines, there is a tendency for the engine to knock.

He explained that knocking is caused by the explosion of the gasoline-air mixture in the cylinder, in contrast to the regulated, slow-burning process of regular combustion. This explosion causes vibration of the metal parts and produces extremely high pressures which will result in cracked pistons, broken wristpins, and blown gaskets if allowed to continue for any length of time.

There are many substances, he said, that can be used to raise octane rating, or anti-knock quality, of gasolines, but tetraethyl lead is the best at present because only a small quantity is needed as compared to the required quantity of a chemical like benzol.

He said octane ratings have gradually increased to the present-day range of 80-82 for premium fuels, and predicted that by 1950 they will be up to 87-90. There are also experiments being made on a mixture of triptane and tetraethyl lead to be used in extremely high-compression engines.

College of the City of New York

Epitome of traveling comfort is riding on air, C. G. Currie of U. S. Rubber Co. said, speaking before the April 16 meeting of the CCNY Student Branch. But the apparently simple problem of putting air in a rubber tube, wrapping the tube on a rim and rolling on the tube entails a good many design difficulties. Most of these are caused by stresses and heat developed within the tire.

For instance, he said, groove cracking may result from stress concentra-

SAE National West Coast

Transportation & Maintenance Meeting

Biltmore Hotel
Los Angeles

Aug. 21-22

THURSDAY, AUGUST 21

10:00 A. M. — BRAKES
Earl B. Richardson, Chairman

Brake Operation Troubles – Julius Gaussoin, Silver Eagle Transportation Co.
Prepared Discussion by: A. H. Tinnerman, T. H. Thomas, Albert Hetzel, F. C. Lynch.

2:00 P. M. — MECHANICAL WEAR—HOW TO REDUCE IT
E. R. Donner, Chairman

Lubrication – W. M. Sopher, Union Oil Co. of Calif.
Prepared Discussion by: Rex Taylor, Frank Costanzo.
Chrome Plating – Col. Harry O. Mathews, Standard Brands, Inc.
Prepared Discussion by: Lee Doty, E. V. Berry, Ralph Teetor.
Shot Peening – Fred K. Landecker, Metal Improving Co.
Prepared Discussion by: A. T. Witham, Leo Schapiro.

8:00 P. M. — FLEET OPERATION
Murray Aitken, Chairman

ADDRESS BY COL. L. L. BEARDSLEE, GENERAL MEETING CHAIRMAN

Fleet Operation Is Important Business – Col. Fred C. Horner.
Prepared Discussion by: Wade Sherrard, Al Pearson, C. T. Thomas, A. J. Eyraud, J. W. Sinclair.

FRIDAY, AUGUST 22

9:30 A. M. — TRANSPORTATION AND MANAGEMENT PROBLEMS
Dr. Vernon D. Keeler, Chairman

Regulations – Col. E. O. Sawyer, Western Motor Transport.
Prepared Discussion by: David G. Schearer, J. Allan Davis.
Driver Selection and Training – Dr. V. F. Larsen, V. F. Larsen Co.
Prepared Discussion by: William A. Baker, Lloyd W. A. Erxleben, R. H. Emmett.

2:00 P. M. — SELECTION AND APPLICATION OF EQUIPMENT
Hugh P. Kanehl, Chairman

Trucks – J. Nevin Bauman, White Motor Co.
Prepared Discussion by: R. N. Reinhard, C. M. Allen, L. S. Koenig.
Trailers – V. M. Drew, Fruehauf Trailer Co.
Prepared Discussion by: C. R. Mills, John B. Clark, A. J. Eyraud.

6:30 P. M. . . . . Banquet . . . . FRIDAY

C. E. Frudden, SAE President

Scientific Maintenance

A. T. Colwell, Thompson Products, Inc.

tion at the root of the treads; rubber deteriorates rapidly when stressed and subjected to the ozone generated when heat and static friction are developed between road and tire; power consumption is an important factor, since if the tire consumes a lot of power while running it will convert it into heat which is detrimental to tire life.

Variability of road conditions, too, is important. Tests conducted by U. S Rubber Co. bring this point home vividly. The average passenger car tire life in Kentucky towns is 2000 miles, as compared with 20,000 miles in the city of Detroit. Average life for 30 cars in Los Angeles was shown to be 16,610 miles, and for the same number in Detroit, 27,250 miles.

Currie discussed new developments in the field of tire fabrics, particularly the still-experimental steel wire cloth. Two plies of wire can carry the same load as 12 plies of rayon. He passed samples of a 2-ply wire aircraft tire segment through the audience. With developments like this taking place, it was pointed out that opportunities for mechanical engineers will not be lacking in the field of rubber. Each new development requires a change of equipment to manufacturers.

His talk ended with an informal discussion on the advantages of various synthetic rubbers in different applications.

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Future engineers at CCNY were given an inside glance at the use of existing data for new design when Fred Peters, editor of "Materials and Methods," spoke before the April 23 Student Branch meeting.

Although new developments occur constantly and are always available for use, Peters said, average practice is to use a handbook 30 years old.

He discussed a number of accepted fallacies and showed how they have been disproved:

1. "Cast iron must never be greatly stressed." Today alloyed or heat-treated cast iron can give 80,000 psi. Its high energy-absorbing ability has been recognized in several modern usages such as in Ford cam- and crankshafts.

2. "Magnesium is poor in corrosion resistance." Actually, it has excellent corrosion resistance to salt spray and air.

3. "Zinc die castings are porous and unsound." This has been disproved by new improved alloys and methods of casting. Impact resistance and fatigue life have been greatly improved.

4. "Plastics are inherently low in strength." New plastic laminating with glass fiber cloth gives strengths up to 75,000 psi, and excellent strength-weight ratios.

5. "Scrap metals are poor in quality." They passed Army specifications during the war, are now called "secondary metals" to remove former stigmas.

6. "Fatigue failures are caused by crystallization." This fallacy arose from the fact that all metals are crystal in structure, and repeated movement between ruptured pieces in a brittle failure gives the fracture a glazed look.

Peters discussed outstanding new processes and developments, including Plutonium 239, the first man-made element; heat-resistant alloys for use in highly stressed and high temperature jet engine applications; the new NE series of steels developed for the automotive and aircraft fields; the rise of magnesium and aluminum as engineering materials; and advances in powder metallurgy, precision casting, shot peening, and induction heating.

On any design job, he advised students, look first for a better way to do it, then design the parts for work ability and to get the maximum use out of materials available. When making specifications that have been used over and over again, make sure that you know why . . . you may be doing the wrong thing.

California Institute of Technology

An unusually large turnout of Caltech Student Branch members greeted presentation of a paper on turbojet engines by John M. Heldack of General Electric Co.'s Engineering Division, May 21.

Heldack showed a series of slides of the turbojet from the smallest assembly groups to some of the aircraft now using it, such as the Bell P-59, the first American military jet-propelled plane; the Lockheed P-80 "Shooting Star"; the Ryan shipboard fighter using both jet and conventional propulsion; and the new Douglas 558 transonic plane that carries a GE TG-180 jet engine; a Westinghouse jet engine; and rocket engines.

In the bomber range, he showed Consolidated Vultee's XB-46. This plane has two nacelles each containing two jet engines; speed is rated in the 500-mph class.

Basic principles of the GE turbojet are quite simple, he said. Air from the scoops is compressed, mixed with fuel as low in octane rating as kerosene, and introduced into one of 14 identical combustion chambers arranged almost parallel to the axis of the fuselage.

As the products of combustion leave the chambers, about 2/3 of their energy is used to operate a turbine that turns the compressor and powers the accessories. The other 1/3 of energy goes into thrust. Because of the simplicity of the basic principles, the speaker was able to go into detail about the accessories and various engineering problems encountered in the turbojet's design and use.

Heldack discussed the GE "I-40" in

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Tractor Meeting Plans Crystallizing

Arrangements for the 1947 SAE National Tractor Meeting, Sept. 17 and 18 in the Hotel Schroeder, Milwaukee, are nearing completion, according to Vice-President B. G. Van Zee, of the Tractor and Farm Machinery Engineering Activity.

Chairman C. T. O'Harrow, of the Activity's Meetings Committee, has received acceptances from seven authors on subjects ranging from optimum tractor speeds for tillage, planting, and harvesting, to detailed equipment design, tractor service, operators' comfort, and butane and propane fuels, and elimination of combustion knock.

At press time, the speakers who had accepted invitations to speak at the event represented four tractor and equipment manufacturers, and two petroleum refiners.

The program, according to O'Harrow, will be rounded out with two or three additional papers to give the meeting the best schedule of technical material offered by that Activity to date.

TECHNICAL COMMITTEE PROGRESS

Car Features Occupy SAE Standards Groups

SAE's standards work in the passenger car field, participated in by several groups, is steering toward the goal of a less costly, safer, and more comfortable vehicle through the development of such items as standard barrel locks and keys, uniform brake tests, and basic knowledge of riding comfort.

Under the aegis of the Body Engineering Committee, a subcommittee headed by E. L. Allen, Schonitzer Engineering Co., is preparing recommendations for a minimum number of lock sizes. Aim here is to develop a series of locks accommodating the greatest number of body entrance doors, luggage compartment lids, instrument panel compartment doors, and ignition locks. Chairman Allen says that standardization of certain overall dimensions of these locks will follow.

Immediate consideration is being given to a uniform nomenclature for locks and lock parts. Much diversity exists in the industry for names of the locks in question. The terms barrel lock, cylinder lock, key lock, tumbler lock, and pillar lock have been applied to the same product.

For the time being, study will be limited to the complete lock – including the plug and outer shell – as in the door panel, with an extension into the door latch.

The subcommittee will delve into specifics such as practical tolerances on both lock barrels and attaching means; standardization of square and rectangular shaft cross-sections of door locks; and tolerances on these shafts as well as the holes in the door latch to receive them.

Earmarked for future effort are investigations involving keys and lock lubrication. Preliminary discussions pointed to a need for both recommended key strength in inch-pounds of torque and plug and lock lubrication to prevent sticking

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and freezing in cold weather.

Important in the safety area is the SAE Brake Committee's three-point test development program. This is an attempt to find satisfactory standard techniques that answer the question of manufacturer, law enforcement agency, and vehicle operator: "How effective are the brakes?"

According to brake test subcommittee Chairman S. G. Tilden, of S. G. Tilden, Inc., his group's scope encompasses the development of:

1. Standard method of measuring stopping distances;
2. Testing means for law enforcing agencies;
3. Uniform sequence of tests to determine performance of brakes in the hands of operators.

The first test will be designed primarily for manufacturers' usage since it will involve engineering features such as pedal and line pressure checks requiring laboratory facilities.

Law Enforcement Tests

Developing a brake test suitable for use by legal authorities imposes several serious problems. Such a test must be simple and quick to perform as well as sufficiently precise for enforcement purposes.

Discussion at recent subcommittee meetings points to the instrument for measuring brake effectiveness as the crux of the problem. Decelerometers now widely used at inspection stations were said to be inaccurate by at least 10%. They almost always give a reading less than the measured stop. Since the decelerometer does not take hold until the brakes do, it measures only brake effectiveness separate from the operating system. No indication of possible lag in the operating system is obtainable.

A more accurate, but more cumbersome, method is use of the fifth wheel

turn to p. 98

Ponder New Practice For Drafting Tolerance

AN unconventional method of applying tolerances to locations of points and holes on drawings – with a "true position" note – was brought up for consideration at the last meeting of the SAE Aeronautical Drafting Manual Committee.

The present practice of tolerancing locates a point from two rectangular coordinates, with a plus and minus tolerance on both dimensions. As shown in Fig. 1, the point on the actual part may fall any place within the rectangular area bounded by the total tolerance on each of the two locating dimensions.

Committee discussion indicated that noting the tolerance from the theoretical true position of the point in terms of a radius is sounder manufacturing practice. It narrows the allowable variation in the point's location – if accuracy is important. It also gives greater control in tooling and gaging by fully exploiting a given tolerance, as Fig. 1 shows.

Further study of the "true position" note will be made, to find if the greater tolerancing efficiency it offers merits the more complex dimensioning and industry education called for.

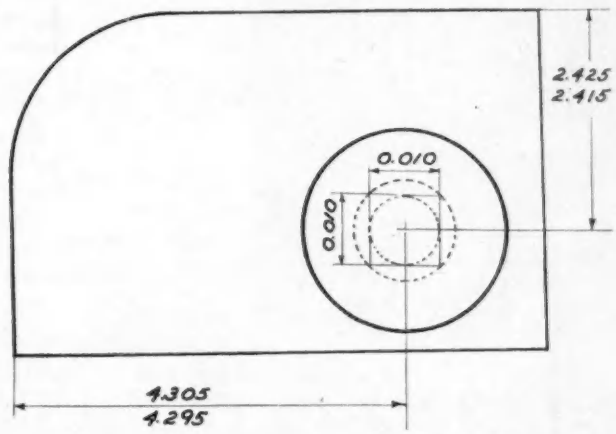
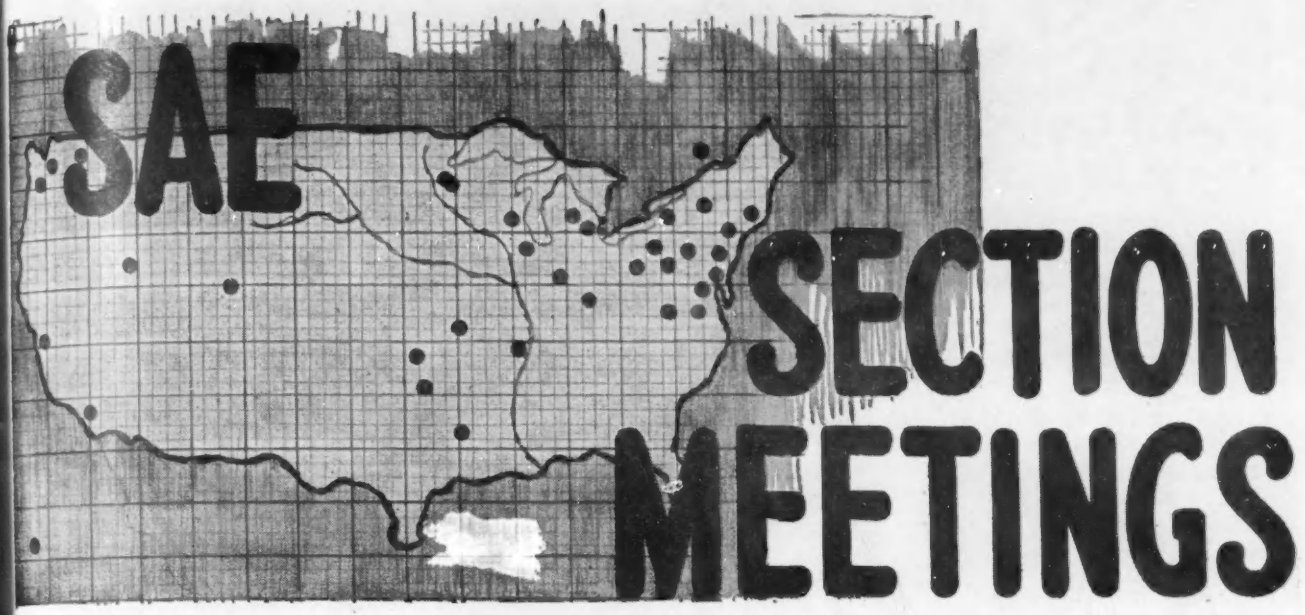


Fig. 1 – Tolerance application in present drafting practice allows a point to fall within the rectangular area 0.010 in. x 0.010 in., as illustrated. The SAE Aeronautical Drafting Manual Committee is examining the possibilities of designating the tolerance as a radius from the point's theoretical true position.

If greater manufacturing accuracy is desired in this case, the "true position" note would call for a tolerance of 0.005 in. from the true position (shown by the smaller dotted circle). If full advantage is to be taken of the tolerance the present system allows, for a greater latitude in tooling and gaging, the note would call for a tolerance equal to half the diagonal of the rectangle (shown by the larger dotted circle)



Students Hear Stout On Bugs, Engineering

by W. F. SHERMAN, Field Editor

DETROIT Section, May 6 – For most SAE members the following few lines are sufficient to recreate the form and substance of this meeting:

"Sons of Norway" story . . .
"Hell-i-copeter" story . . .
"Elephant in the Garden" story . . .
"Built-In Head Winds" . . .
"A Propeller is Just a Boomerang"...
"Inventing Rubber Gloves for Leaky Fountain Pens" . . .

Yes, it was Bill Stout's night with some seven or eight hundred members present at a junior student meeting, including students from eight Michigan engineering colleges.

Stout addressed the group on "A New Approach to the Flight Problem" in the Horace H. Rackham Educational Memorial.

Students of the Section, having suggested the meeting, also suggested Stout as the speaker and turned out in throngs to hear him.

At the speakers table with him were chairmen of the eight Student Branches: Richard Teasel, University of Detroit; J. Tierney, Chrysler Institute of Engineering; Robert Delderfield, Michigan State College; Paul Vickers, General Motors Institute; A. E. Nash, Lawrence Institute of Technology; Gerald Arnet, Ford Engineering School; R. A. Marinelli, Detroit Institute of Technology; Alexander Brede III, University of Michigan. Each student had an opportunity to outline the activities of his branch before Stout spoke.

The talk dealt with Stout's insect flight project which he said was "started on a sort of dare" with the intention of inspiring some young engineers to experiment on a scale they can afford to pay for themselves. He said that on this project he has "at times employed up to one man, including myself, spent a total of about $15 – and, so far, have been up before three engineering societies trying to explain it."

His progress in learning about insect flight was discussed and demonstrated with his "geflopigator" and "geflopigatus giganticus," as well as with slides and motion pictures, including a Sperry Gyroscope film depicting, in ultra slow motion, "One Second in the Life of a Humming Bird," and the flight of a fly.

Young Engineers Urged To Look Beyond Field

by R. N. YEAGER, Field Editor

SAN DIEGO Section, May 7 – Young engineers in pursuit of success should broaden their study to explore non-engineering fields, Edmund T. Price, president of Solar Aircraft Co. and the San Diego Chamber of Commerce, told this meeting.

Because engineers in this age of specialization must rely heavily on other groups of specialists – manufacturers and salesman, for instance – Price urged students to enhance their own future value by gaining a broader comprehension of other aspects of the business world.

"The basis of business," he said, "is manufacturing and sales . . . engineering and accounting only round out the picture." Thus he asked students, rhetorically, "how much do you know about the other three major branches of business?" and showed, by examples of what they might be up against in their professional careers, how lack of such knowledge could pull them down.

He urged broader education, broader objectives, and a broader outlook on life in general as important stepstones to engineering success.

Outlines Refining Progress at Panel

by CHARLES FOELL, Field Editor

METROPOLITAN Section, May 1 – To all intents and purposes, petroleum refiners are in the chemical business and can produce any wanted hydrocarbon product the customer wants.

But according to A. B. Culbertson, who spoke at this panel meeting, use must be made of every byproduct if a refinery is to stay in business.

The Shell Oil Co. technologist pointed out that cooperative research done by the major refineries in this country during the war years had telescoped decades of normal work into a few years, and knowledge and experience with molecular physics and chemistry has reached a point where almost any conceivable product can be made.

Basic economic factor is, however, that a profit must be made from each barrel of crude oil. Because of the vast amount of raw material used by the industry, byproducts must be disposed of. There are no storage facilities for partly-refined products.

As a result, when a new product has been developed, the refinery must also develop further refinery techniques to make the byproducts valuable to some one.

During discussion, several petroleum technologists warned diesel engine operators that if they want fuel of higher volatility, they will be competing directly with the demand for oil burner fuels.

EXPERTS TURN ACTORS TO DEMONSTRATE TRUCK-BUYING TECHNIQUE

Above: Austin M. Wolf (left), consulting engineer, played a real life part at the May 14 meeting of Metropolitan Section, when T. L. Preble (center) represented a confused would-be buyer of trucks who brought his troubles to Wolf. Joseph Adelizzi (right), another "consultant," helped on the questions of state restrictions

Left: By the time Preble had asked a few questions, Wolf's "office" was full of experts. Met Section Chairman W. E. Conway (left) closed the meeting and thanked the experts. Seated at his left are R. B. George, who gave Preble advice on trailers; Frank R. Nail, who explained size of engine required; Wolf; Preble; E. M. Nuttila, who experted on transmissions and rear axle ratios, and Adelizzi, an authority on state highway laws

by CHARLES FOELL, Field Editor

METROPOLITAN Section, May 14 – Six Metropolitan Section engineers turned actors tonight to illustrate vividly what a fleet owner is up against when he buys a truck. They showed how the fleet operator is forced to satisfy the triumvirate of state laws, operational needs, and highways traveled.

Vehicles must keep within legal limits of length, height, width, weight, and tire loading in each state through which they pass. At the same time, the vehicle must be capable of carrying the type and quantity of cargo that yields a reasonable profit to the operator with a minimum of maintenance worries.

Joseph M. Adelizzi, managing director of the Motor Carrier Association of New York, pointed out that New York, New Jersey, Connecticut and Pennsylvania regulations governing motor trucks are among the most liberal in the country. These states permit a tractor and semi-trailer combination weighing 45,000 lb, provided each inch of tire width supports no more than 8000 lb. Dimensionally, a vehicle 96 in. wide, 12½ ft high and 45 ft in overall length satisfies the laws of these four states.

Kentucky limits vehicle height to only 11½ ft. While the operator can run vehicles up to these maximum heights, underpasses and bridges encountered may dictate lower-height vehicles, warned Austin M. Wolf, consulting engineer. He also cautioned operators to check legal load limits on axles. A 20,000-lb-per-axle loading will satisfy New York and its three neighboring states.

With legal limitations met, the buyer proceeds next to have a vehicle tailored to his requirements. Frank R. Nail, assistant to the chief engineer, Mack Mfg. Co., pointed out that the engine must develop enough power to overcome air and rolling resistance, accessory power losses, and friction losses. The engine must carry the vehicle at economical speeds over both level roads and grades.

The public-relations-conscious fleet operator wants his vehicle to keep up with, not hinder, traffic, said Theodore L. Preble, automotive transportation superintendent of Tide Water Associated Oil Co.

But too fast a vehicle takes its toll in two ways: the greater the speed, the fewer miles the vehicle will travel on a gallon of gasoline; and required horsepower, indicative of engine size, increases as the square of the speed.

Nail offered the horsepower index as a ready tool for quick determination of engine power. If a 40,000-lb vehicle powered by a 120-hp engine can travel 46 mph on the level and 23 mph on a 3% grade, any vehicle with an index of about 330 lb of weight per hp will give roughly similar performance.

Other factors enter into a vehicle's grade-negotiating ability. The transmission's gear reduction and the rear axle ratio must be so designed as to allow starting on the steepest grade of the run in case the vehicle stalls, according to M. E. Nuttila, motor vehicle superintendent of Cities Service Oil Co. An SAE formula tells motor vehicle designers and operators the gear and axle ratios required to travel over given grades at desired speeds.

Tailoring the cargo-carrying trailer to specific needs also enhances operational efficiency, Trailmobile Trailer Co.'s vice-president Ralph B. George observed. To supply the best trailer for the job, the manufacturer must know the kind of payload the operator in-

tends to carry, how and where he will load and unload it, and how much will he hauled each trip.

All these factors represent the scientific phase of running a fleet, but much remains an art, Preble said. Maintenance and depreciation still stand out as prime headaches in a fleet operator's life. The science of prediction falls down in advising the operator of the economic life of the vehicle and how much it will cost to properly maintain the truck or bus during that time.

With mechanics' wages 233% above prewar level, the operator is more than ever on the hunt for vehicles with easier-to-get-to and longer-lasting parts. According to Preble, the vehicle builder should concentrate on bettering nickel-and-dime items. Road failures from a blown-out fuse or an electrical wire short necessitate sending a crew to the vehicle and loss of both its utility and that of the driver.

W. R. Cubbins, Jr., Metropolitan Section's vice-chairman elect for T&M, conceived and arranged the meeting and directed rehearsals. He said: "Only through meetings and technical committees of the SAE can both commercial vehicle operators and manufacturers solve mutual problems to produce more efficient and economical commercial transportation."

Speakers' sponsor Val J. Roper of GE (left) talking to Speaker Harry A. Winne and M. J. Hamner, also of GE

Heat Is First Step To Atom Energy Use

by WILSON B. FISKE, Field Editor

CLEVELAND Section, May 12 – The only usable form in which we can make atomic energy available today is heat resulting from the chain reacting fission of an atomic fuel, such as U-235, Harry A. Winne told this meeting.

Winne, who is vice-president of General Electric Co., spoke on "Application of Nuclear Energy to Power Generation." In the foreseeable future, he said, it does not seem feasible to convert atomic energy directly into electrical energy.

The only natural material that will sustain a fission chain reaction is Uranium-235, which is found combined with Uranium-238 in the ratio of one part in 140. Plutonium, derived from U-238 in a U-285 pile, is a suitable atomic fuel. Thorium also can be converted to an artificial atomic fuel. There seems to be no immediate possibility of finding any natural material other than U-235 that will maintain a chain reaction. We can forget such claims as that ordinary clay can be used as a source of power, Winne said.

The heart of every proposed atomic powerplant is the nuclear reactor, or atomic pile. In this pile the atomic fuel will undergo fission, the energy released appearing as heat. This heat must then be conveyed out of the pile by a circulating heat transfer medium such as a gas, a fluid, or a liquid metal. This heat transfer medium will flow through a heat exchanger, giving up its heat to water, thus generating steam that can be used in a conventional turbine to generate electricity.

Design and construction of the pile involves many difficult problems in nuclear physics, chemistry and metallurgy. While the piles at Hanford, Wash., for the production of plutonium produced large quantities of heat, its temperature still was too low to be useful. Piles are now being designed whose temperatures should be high enough, but none are yet operating.

One necessary feature for any power pile, and one that will restrict the field of operation, is the shield. For complete protection it must be several feet in thickness and composed of fairly heavy material.

Thus, Winne said, even if the reactor itself could be made in comparatively small physical dimensions, overall dimensions of the pile will have to be large, and its weight will be more than enough to crush the very largest trucks, to say nothing of passenger cars. Therefore, there is no possibility – in the light of present knowledge – of using an atomic powerplant in an automobile. Its application to aircraft seems improbable, and to locomotives unlikely at best.

First "commercial" application may be on a large ocean-going vessel. Use of an atomic powerplant would probably free a vessel from the need of frequent refueling, because atomic fuel is such a concentrated source of energy; if 1 lb of U-235 undergoes complete fission, it will release heat equivalent to that obtained from burning 1500 tons of coal. Thus one charge of fuel in the pile should enable a vessel to make many round trips across the Atlantic.

Land installations probably will be made first, he believes, in localities where conventional fuel is expensive and power is needed.

The "when" question, Winne said, cannot be answered with any degree of accuracy. Experimental, small plants now projected at some of the Atomic Energy Commission laboratories may be operating within two to five years. But these are only the first step, and many technical problems must be tackled before a large practical plant can be built.

The economics of atomic power are even more unknown. First cost will almost surely be higher than that of conventional fuel-fired plants, and oper-

In the seat of GE's automobile light display piece are (l. to r.) Roger Welder, White Motor Co.; Edward K. Brown, Crane Packing Co.; and Walt Howard, White Motor Co.

ating cost can hardly be guessed. Initial cost of atomic fuel may be determined by political considerations. It is not known how frequent or how costly it will be to reprocess the fuel partly consumed in the reactor.

In any case, he said, atomic energy can only affect fuel cost, and this represents only about 20% of the total price paid by consumers of electric power from public utilities.

We must think in terms of decades rather than years, Winne concluded, in any estimation of when atomic power can compete with present methods of power generation. If and when it does begin to compete, the growth of such competition will be slow and gradual. He believes there will be no revolutions in methods of power production; that atomic power will supplement rather than supplant present power sources.

Data Still Scarce On Prerotation Device

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, May 8 – Many suggestions have been made for prerotation of landing gear wheels, but very little has been done about it. So said two representatives of Lockheed Aircraft Corp., E. R. Warner, assistant project engineer, and J. F. McBrearty, structures engineer, speaking at this Section's aircraft engineering meeting. They said that although some tests have been conducted, technical data are scarce.

Economically, installation of prerotating devices on airplanes would add weight. The big question is "Will it add profit?"

Of course, it would increase tire life, but tire life would have to be prolonged considerably to warrant installation of the required mechanical actuator. In addition, there is the possibility that added passenger comfort might be gained by the eliminated "bump" normally experienced with landings.

If the device is used, it must be reliable. With this condition, prerotation will reduce landing loads.

Wind tunnel tests have at least established a set of requirements. Among these are: wheel speed must be established within two minutes, and wheels must be turned by a direct motor drive (no gears . . . motor is mounted inside the brake drum).

Built-in vanes on tires have been tried. Experiment showed that revising vane angles improved results, and that vanes helped in air speeds above 120 mph.

Two moving pictures were shown; one pictured Navy planes making carrier landings, and the other provided close-up, slow-motion, color shots of landing gear and wing reactions during impact landings.

Canadians Hold Gala Last Meeting

by WARREN HASTINGS, Field Editor

CANADIAN Section, May 6 – Canadian Section's annual Oshawa meeting was held in the Genosha Hotel with Retiring Chairman C. E. McTavish in the chair for business sessions and Retiring Regional Vice-Chairman Kenneth H. Braithwaite presiding for the remainder of the meeting.

Three presentations and an acknowledgment of the historic gavel presented to British Columbia Group were among the distinguishing features of the meeting. Retiring Chairman McTavish presented to the Section a fully-equipped and suitably-inscribed reading crown for the electronic gavel given the Section by George J. Beattie on his retirement as chairman a year ago. Chairman-Elect Ed. F. Armstrong on his installation presented the retiring chairman with the working tools of an Isaak Walton.

Dean of the Canadian members of the Society (1909) Col. R. S. McLaughlin, past president and chairman of the board of General Motors of Canada, gave on behalf of the Section a desk set to the retiring secretary and vice-chairman-elect, Warren B. Hastings, in recognition of his motion that brought Canadian Section into being and his 20 years' service as secretary.

McLaughlin expressed his pleasure in being "in his old haunts." He declared that automotive engineers had done and were doing a "magnificent job," and that future opportunities are at least as great and as challenging as those of the past. He regrets, he said, that his three-quarters of a century deny him the luxury of being in the front lines of the impending campaign of progress.

Initial action of Chairman-Elect Ed. F. Armstrong, left, on his installation was presentation to retiring-Chairman C. E. McTavish of the panoply of "The Compleat Angler" as a token of Section appreciation. Visible is the inscribed and fully-equipped reading "pulpit" given the Section by McTavish

Principal speaker was Dr. H. E. Wolf of General Motors Research Laboratories. Speaking on "Trends in Automotive Fuels and Lubricants," Wolf explained how shortages have impeded refinery reconversion and expansion, predicted the fuel shortage situation will get worse before it gets better. Today's improper fuels play an important part in acid etching, varnish and sludge formation, he said. He indicated that the general availability of fuels of the type that will permit the doubling of compression ratios is very considerably more remote than tomorrow.

A pioneer trio of Canadian Section. Right: Col. R. S. McLaughlin, dean of Canadian members of the Society (1909) and an outstanding Dominion patriot and philanthropist. Center: George W. Garner, senior past-chairman of the Section present at the annual Oshawa dinner meeting. Left: Warren Hastings, retiring secretary and vice-chairman-elect, whose motion, seconded by Garner, brought the Section into being. Photograph was taken after McLaughlin presented Hastings with a desk set in recognition of his service

Nostalgia, Lubricants Mingle at Vancouver

by J. B. TOMPKINS, Field Editor

BRITISH COLUMBIA Group, May 15 – Far cry from its 1947 sisters, an 1898 model Winton stole the spotlight during this British Columbia Group meeting. At the first "official" visit of a Canadian Section member to the new Group, C. E. Tilston, manager of the industrial division of Imperial Oil, Ltd., presented B. C. Group Chairman Phil J. Schrodt with a gavel emblematic of the second car manufactured on this continent and the first in Canada. In his address, entitled "Automotive Topics," Tilston outlined the progress made in lubrication of automotive engines. He was introduced by Imperial Oil's B.C. sales manager, Gordon Scott.

Tilston, veteran SAE member who launched his automotive career with Willys-Overland after World War I, said that "back in those days we had only one grade of lubricating oil." But in the intervening years, he said, great strides have been made in the construction of automobile engines . . . advances in horsepower, compression, and tolerances that would have been impossible if the lubrication phase of the industry had not kept pace.

"Lubricants have advanced with fuels," he declared. "A good oil today must do much more than merely provide a slippery surface. It must provide an oil seal as well as lubricant. It must dissipate heat as well as clean the engine. And there must be a complete range of oil as evidenced by ratings set up by the SAE. Today's lubricating oil should have a good viscosity index. Additives must be used to increase the pour and viscosity properties of lubricants rather than relying merely on the quality of crude."

The high heat generated by heavy-duty and hardworking motors today makes an engine a virtual chemical plant, he said. Under these heats the oil "breaks down" unless proper additives are employed.

How long should we use or drive an oil?

Tilston told his audience that in passenger cars 1000 miles still remains the safe and sane period – a cheap investment compared to the original investment in the vehicle. Comparing oil to a cake of soap, he cautioned the SAE members and guests that oil, like soap, diminishes with each washing; that the working life of the oil and its cleaning additives is dependent on the motor's service and speeds. Additive-type oils will be asked for more frequently, he added, as gasoline octane ratings increase.

"Most people blame lubricants for motor troubles ranging from engine deposits and burnt valves to bearing failures," he said. But other factors must be taken into consideration. Bearings have been a wartime headache because of "makeshift" materials, he said. Better air cleaners were listed as a must since sand or dust creates excessive wear. He labeled gum formations as either "tonsil" (before combustion) or "intestinal." In the first instance, the formation can result from use of gasoline that has remained too long in a storage tank. Some contractors store it for as long as six months after a specific job has been completed.

"Don't be alarmed, however," he advised. "The gas in your tank is good for six more months anyway. And more research has been made by the petroleum industry in the past twelve months on gum formation than on any other subject."

Oils marketed today all are tested under severe conditions, Tilston said. Though auto engineers concede the adequacy of today's lubricants, research continues. He believes engine design can be improved – particularly crankcase ventilation on some units. Cooling was said to be a problem with some manufacturers.

He cautioned fleet operators and mechanics to practice preventive maintenance, to make oil changes each 1000 miles at least a rigid rule. And, he said, be sure the speedometer is actually working. Many fleets he had checked had broken or disconnected speedometers.

"Even on trucks where the speedometer is in good working order," he claimed, "the reading is only road miles. What about those periods when the motor is idling – the most severe period for oil dilution?

"And speaking of preventive maintenance and service, one company that complained about engine deposits had a truck stopped by a research man recently, and the radiator took almost a gallon and a half of water!"

Expressing a hope that "cheap cars" would again appear by 1950, Tilston said he looks for more effortless driving and higher compressions, improvements in crankcase ventilation on trucks. He thinks fuel systems will remain substantially the same for some time.

C. E. Tilston (left) presents British Columbia Group Chairman Phil J. Schrodt with a very special gavel sent to the new Group by Canadian Section. Mounted on the base of the gavel's holder is a cross section of one of the original-equipment, molded single-tube tires of Canada's first gasoline car and the second car commercially produced on this continent. Owner of the car was Col. John Moodie, who also brought to Canada its first bicycle, first "safety" bicycle, first motorboat, first knitting machines and first steamer.

Other parts of this historic tire can be found at headquarters of the Canadian Automobile Association, among whose founding fathers were Moodie and automotive pioneer Dr. P. E. Doolittle, and in the office of George W. Sowin, Kitchener Regional vice-chairman elect of Canadian Section and president of the B. F. Goodrich Co. of Canada

MORE SECTION CHAIRMEN

This is the tenth installment in a series of biographies of 1946-47 SAE Section chairmen. Next month will conclude this year's series of biographies.

THOMASSON

. . . . of Northwest

When Dave Thomasson, Northwest Section chairman, moved from his native Virginia to the Pacific Northwest in 1927, he liked the country so well he decided to stay. He had studied law and engineering in night school, while he was working his way up in the Texas Co.; today he is general lubrication engineer for Texas Co. for the state of Washington.

Lubrication, however, is far from Dave's mind when he has time off, for then you'll probably find him along some mountain stream in the Cascades, in British Columbia or Washington. Or, if stream fishing isn't good – and Dave catches them if there are any to be caught – he'll be drifting lazily across some evergreen-bordered lake, trolling for the big ones.

The Thomasson home, on Gregory Heights overlooking Puget Sound, is another of Dave's Hobbies. There he and Mrs. Thomasson work together in their flower garden. His favorites are roses, petunias and gladiolas.

– by Dan P. Cheney, Field Editor

MCTAVISH

. . . . of Canadian

Only those who are careless of being categorized by a Scot as something lower than a Sassenach and of one of the "lesser breeds without the law" would accent, as a radio commentator recently did, the second syllable of Highlander. At such provocation Scotsmen or Scots (not Scotchmen) seize their claymores and make the welkin ring with their martial pibroch.

Western-hemisphere counterparts of the massacre at Glencoe are narrowly averted. To term a tartan a plaid is almost if not quite as bad. Despite the fact that both Burns and Scott used Scotch as a personal substantive, Scots or Scotsmen disapprove of it as a name for anything but their distinctive, if obscure, beverage. The recondite reason for that antipathy only a Gaelic philologist could elucidate.

There are other Scottish mysteries. Scotch potent and plentifully ingurgitated alone makes rationally explicable the rating as music of the cacophonous caterwauling of the bagpipes – or as food, let alone an epicurean delicacy, the culinary conglomeration called haggis. That is by way of overture to another phobia of the Scots. If you know a Charles who is a Scot, the diminutive suffix to employ is ie, not ey – Charlie as in caddie, lassie and laddie. Racial frugality relative to expenditure of ink and effort doubtless had something to do with it.

The chairman of the Canadian Section is a bra' he'lander, although a native of Flesherton, Ont., where he received his primary and secondary education, finishing at Owen Sound. No dour Scot he, but a genial six footer who, stripped to toss the caber, weighs 184 lb.

Few men in the automotive industry are as well known from coast to coast as Charlie E. McTavish. Though usually amiable and bland in demeanor he has demonstrated that when the occasion warrants he can effectively wield the claymore. None present will forget the decisive dispatch with which he stopped the flow of obnoxious obscenity from a professional master of ceremonies at one of the largest dealer gatherings ever held in Canada.

Charlie is the vice-president and general manager of Perfect Circle Co., Ltd., Toronto, and vice-president of Auto Electric Service Co., Ltd. He ambidexterously soared with General Motors of Canada by the alternating steps of service and sales, becoming successively general parts and service manager, assistant general sales manager, general sales manager and director of parts and service of both GM and United Motors of Canada.

A past-president of the Oshawa OML Motor Club and Rotary Club, he is a 32nd Degree Mason and a member of the Empire Club, Toronto Rotary, Wedgewood Hunting and Fishing Club, and sporadically takes a stab at fishing, hunting and golf – the last a grotesque game garnered by the acquisitive Scots from the Dutch who had evolved it as a type of croquet. Close friends with taking ways, the Scots, even with the Dutch-treat Dutch.

– by Warren Hastings, Field Editor

KANEHL

. . . . of Spokane

Hugh P. Kanehl and the automotive industry joined forces in 1904, when Louis Disbrow, of Jamaica, L. I., hired Kanehl to learn about cars by trying to keep a couple of Panhards hitting on all two. Louis later became quite well known as a racing driver, after cars acquired a few more cylinders and miles per hour.

The following year Kanehl joined the staff of Tom Witherbee, pioneer builder of storage batteries for auto ignition, with the Witherbee Igniter Co., now known as WICO.

For 40 years he has run the gamut of engineering activities, from building storage batteries and condensers for

radio telephone transmitters to electrical specialty work on Flanders 20's and early V-8 Cadillacs.

Spokane has been his home since 1914, with the exception of 19 months in the sticks operating a garage and repair shop, and a spell with the Tank Corps in France.

He joined the maintenance crew of his present employer, Inland Motor Freight, as engine repair man in 1932. He became assistant shop superintendent, and finally fleet superintendent, in charge of shops at Portland, Walla Walla, Seattle and Spokane.

Kanehl manages to keep his weight down to a hefty 135 by following a lawnmower over 7000 sq ft of lawn during the summer and clearing snow in winter. He is disgustingly healthy for a man with the 60th milestone the next stop; he hasn't had a sick day since an 8-week spell in a British base hospital in France in 1918.

He smokes, drinks and chews, and can converse freely with loggers, truck skinners and traveling salesmen.

He joined the Society in 1942, when a small group was started as part of Northwest Section. He was Section regional vice-chairman until 1944, when Group status was secured. His present main ambition is to gain Section status for the Spokane Intermountain Section, serving western Montana, northern Idaho, and eastern Washington.

HOOPER

. . . . of Kansas City

W. H. Hooper, Kansas City Section chairman, had enough spare time 40 years ago, between football and other activities at school in Iowa, to build a gasoline engine. In process of starting, the engine became contrary about the direction of rotation. Bill's wrist had to be wrapped by the doctor, but Bill still makes engines (mostly steam) as a hobby in his home in Kansas City, Mo.

After completing his engineering schooling in Chicago, Bill worked for several automotive companies. From 1918 to 1925 he worked for Morris Packing Co., where he became chief engineer. He joined the B. P. Lientz Co., designers and builders of oil refining equipment, in 1925, and was chief engineer when he left in 1931 to become division industrial and lubrication engineer for Phillips Petroleum Co.

Still with Phillips, he is also actively engaged in such spare-time activities as the Oil Men's Club, Kansas City Club, and the AF & AM Ivanhoe Lodge and Ararat Shrine. He has served as treasurer and secretary of Kansas City Section.

As further proof of his diversified interests, Bill's conversation may turn as readily to antique dishes or bizarre philosophies as it does to engineering topics.

– by H. F. Twyman, Field Editor

WALLACE

. . . . of Hawaii

Arthur Ford Wallace, chairman of the Hawaii Section, was born in St. Louis, went to school in Kansas City, and finished his education at Colorado State University with an M.E. degree.

He joined Westinghouse Electric in 1923, and in 1930 sailed on the maiden voyage of the S.S. President Coolidge as guarantee engineer for Westinghouse.

He visited various Oriental ports as well as Honolulu. Hawaii must have got into his blood, for he left Westinghouse in 1937 to work for the Waialua Agricultural Co., sugar producers, and has been there since.

Art is fond of his pipe and cigars, and likes to indulge in a poker session now and then. Rumor has it that he has a horror of parting with dimes. Not nickels, quarters or dollars . . . just dimes.

He is Waialua's factory superintendent. Although the plantation and Art's home are on the other side of Oahu, 40 miles from Honolulu, he has yet to miss an SAE meeting.

He has a daughter, soon to be married, who sometimes remarks quite incorrectly that her dad is getting to be an old man.

– by C. H. Morrison, Field Editor

Steel Versus Aluminum Debated at T&M Meeting

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, April 24 – This Section's Transportation and Maintenance meeting drew an audience of 400 to the Biltmore Hotel in Los Angeles. L. L. Beardslee, who was colonel in command of the 623rd Base Automotive Maintenance Battalion of the U. S. Army from 1940 to 1946 and who has been superintendent of shops and garages for the County of Los Angeles since 1937, acted as technical chairman for the subject "Steel versus Aluminum in Body Construction."

V. M. Drew, director of research for Fruehauf Trailer Co., spoke on "Light Steel Body Construction," and J. H. Dunn, head of the highway transportation section, Development Division, Aluminum Co. of America, presented the subject "Light Metal Aspects of Body Construction."

In Drew's opinion, there are two basic types of commercial body design:

1. Body mounted directly on a load-carrying chassis;

2. Composite structure that carries and encloses the load . . . truss type, stress panel, frame integral, and so forth.

In the first type, the chassis takes the whole load, and the side walls and roof are carried only as load retainers and for weather protection. Weight savings per ton of carrying capacity are in favor of the second type: truss structures provides a symmetrical combination of vertical and diagonal struts and ties properly anchored to top and bottom chords; the skin, lining, and flooring contribute nothing to the carrying strength. Stress panel is almost the reverse; outer panels act as the primary load carrier – they serve as the web section for the girders.

Stress alloy steels have been applied to the stress panel type structure by corrugating the outer panels (corrugations are ½ in. deep and spaced about 1½ in. apart, and act as combination web stiffeners and columnar supports). Such alloys, with high physical properties, have been designed into structures by reducing sizes and weights of component parts. The stronger the steel, the smaller the section area required, and stainless steels generally have no tendency to corrode.

Initial cost of stainless steel construction is high, he admitted, but this factor is undercut by lighter structure weight, minimum maintenance, and reduced replacement. Careful observation of stainless steel units that have been in constant service for from five to ten years indicates definite "metallic permanency." Furthermore, stainless steel structures subjected to localized impact forces have shown a tendency to re-

main intact although the impact area is completely demolished.

Dunn listed three vehicle-load combinations possible as a result of reduced dead load:

1. Assuming the same chassis, lighter units mean greater payload.

2. Assuming the same payload, a smaller chassis reduced first cost, taxes, gasoline, tires, and other items, and gives better speed control.

3. Assuming the same chassis and payload, unit operating expense is reduced.

From a fabrication viewpoint, he said, aluminum and magnesium are not radically different from other materials. Commercial shapes are available. Intricate and efficient sections can be produced by the extrusion process, thus reducing fabrication and assembly time.

For strength, available alloys of aluminum and magnesium are equal to or better than the low-alloy, high-tensile steels. These light alloys deflect more than steel, and this is highly desirable for some conditions such as impact. There are, however, design methods that can be employed if stiffness is important.

Aluminum weighs about 1/3 as much as steel, and magnesium is 1/3 lighter than aluminum. As a result, thicker sections can be used as necessary without excessive weight. Aluminum can be increased to 42% over the thickness of a steel section and still be only half as heavy; a similar increase in magnesium would make the section only 1/3 as heavy.

Susceptibility to corrosion can be overcome by protecting the surfaces and keeping them from contact with dissimilar metals. Exterior aluminum panel surfaces, however, do not require a protective coating and retain an attractive appearance.

"Cost per pound of weight saved" at today's raw material prices, Dunn said, would be about 20¢ for aluminum and 40¢ for magnesium. This means that replacing 1000 lb of steel with 500 lb of aluminum would add about $100 to the material cost, and replacing with 330 lb of magnesium would add about $275. But operators' evaluation for each pound saved is $1 per year, so that added material cost would be quickly paid off.

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Northwest – Dan P. Cheney
Oregon – J. M. Lantz
Peoria – Earl S. Tomkinson
Philadelphia – R. W. Donahue
Pittsburgh – Murray Fahnestock
St. Louis – No appointment
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Colorado Group – No appointment
Mohawk-Hudson Group – Gene O'Haire
Salt Lake City Group – C. W. Sissman
Spokane Group – No appointment
Virginia Group – Jean Y. Ray
Williamsport Group – Robert B. Ingram

Presents Fundamentals Of Four Spring Types

by MURRAY FAHNESTOCK, Field Editor

PITTSBURGH Section, May 23 – With the able help of Dave Proudfoot, the Oil City Group and sunny skies, Pittsburgh Section enjoyed an afternoon sports session at the Wenango Country Club, followed by a dinner and evening technical session.

Speaker Murray Fahnestock, editor of Ford Field Magazine, said:

"Let's look at all four . . . leaf springs, coil springs, steel torsion bar springs, and rubber torsion spring suspensions." Using slides and speaking from notes, he traced the "evolution of spring species" from Nature's examples of bendable leaves and the torsional tendrils of vines which, he said, were ahead of the engineers because they have a reverse twist; through the development of the various species used for passenger cars, buses, trucks and trailers – and explained practical reasons for the differences.

Comparing the static deflection of a spring to a pendulum, Fahnestock said, "There is no substitute for static deflection as one of the means of obtaining a lower oscillation rate; although shackle angle is also important."

Fundamental advantage of independent suspension of the four wheels is that a suspension system of A-bars and control rods permits a large vertical movement of the front wheel spindles without interfering with steering. With such control linkage, either leaf springs (as used in Studebakers and the new Willys) or coil springs (as used in other cars) will function efficiently.

For the rear springs of passenger cars, the semi-elliptical leaf springs probably will be continued and may gain new adherents for 1948, as they combine the advantages of the Hotchkiss drive as used on many of the finest cars and the possibility of variable rate, as used on Pontiac.

This variable rate is especially valuable for rear springs, where the weight of the car may vary from that of only the driver, to that of six or more passengers plus luggage.

"Shackle angle is important," he said, "as Chevrolet proved by changing the shackles of its semi-elliptic rear spring from a type that placed the main leaf under tension, to a type and angle of shackle that place the main leaf under compression, thus decreasing oscillation rate.

Bending an eraser to show that materials are stronger in compression than in tension, the speaker used slides to show how the weight of leaf springs could be reduced by removing metal from the compression side by grooving, or by using parabolic section or other means to equalize the strength of the tension and compression sides.

"Buses," he said, "are a fertile field for innovations in spring suspensions. Buses are produced in smaller numbers, and their weight may range from 1500 lb on the front springs (with only the driver) to 4200 lb with a full complement of standees.

"That is why leaf springs of the progressive or variable rate type are so generally used. . . . While torsion bar springs of steel or rubber give a variable rate (because of the circular path of movement of the torque arm) it is

CLOSING DATE

SAE Journal strives, in these pages, to bring to Society members live, prompt news coverage of every Section meeting. Material is provided by section field editors.

With dates determined by printing schedules, this issue covers all Section meeting news received in New York up to June 15.

difficult to achieve desired rate variations in the intermediate positions."

Coil springs used on passenger cars, he said, are fundamentally torsion bars, in that they twist as they deflect. They are coiled merely for the sake of compactness. To achieve American standards of riding comfort, bars from which automobile coil springs are made are more than 10 ft long.

In discussion following Fahnestock's paper, Norman Werner, manager of Ed. Werner Storage & Transfer Co., attributed a 24% saving in tire wear to the use of shock absorbers (which should actually be called "dampeners") on his tractor trailers. He said he hadn't broken a spring since he began using them. Commonest mistake, he said, was using shock absorbers of insufficient size because truck buyers insist on low prices.

Question was asked whether the lubrication of springs that had been allowed to run dry for some time was not conducive to spring breakage. R. N. Austen, of Iron City Spring Co., said springs were sent from the factory lubricated with grease and graphite, and that the restoration of original operating conditions should not cause breakage.

But, he said, lubricating springs without adjusting shock absorbers might cause trouble because of the greater range of movement of lubricated springs when shock absorbers weren't functioning.

Answering the much-debated question as to which spring makes most efficient use of steel, Fahnestock said a torsion bar spring might be compared to a hired cook, employed at $25, while a leaf spring might be compared to a wife who, while she might cost more than $25 a week, was something to be proud of socially, could sew on buttons, and so forth.

The discussion was still going strong when the club attendants moved to close the club for the night, and the members from Pittsburgh began their 90-mile trip for home.

Power and Economy Cited as Diesel Needs

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, April 10 – Five hundred SAE members and guests heard some interesting facts about power in general as C. G. A. Rosen, of Caterpillar Tractor Co., spoke to them on "The Possibilities of Diesel Power."

He told them, for instance, that only 0.1% of the potential power of the A bomb is actually utilized, and that it took 8½ tons of alcohol and oxygen 53 sec to send the V-2 bomb 24 miles up.

There has been measurable progress in diesel engine development, Rosen said. For instance, it was once thought that 4 in. was minimum for a cylinder bore, but bores now are down to 2½ in. with a 2⅝-in. stroke, and the engine running at 6000 rpm. A smaller fuel injector was developed to study spray characteristics and performance; this injector can be used in a 2¼-in. bore cylinder and also in an engine developing 200 hp per cyl.

Other combustion studies have included combustion temperature measurements made by breaking down the flame spectrum and recording the red and green ranges on an oscillograph screen . . . temperature is determined by measuring the difference between resulting curves.

Diesels can be adapted to assist other power generation units. For example, he said, opposed-type diesels can be utilized as superchargers to feed gas turbines.

On the sales side of the field, consumers want high output, low maintenance and low fuel consumption.

Section Hears Results Of Two Fuel Test Programs

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, May 22 – More than 400 members and guests enjoyed this Section's first dinner meeting in two years at the Roger Young Auditorium in Los Angeles.

The paper on "Field Performance of Heavy-Duty Lubricating Oils" was prepared by F. W. Kavanagh, assistant manager of plant products for California Research Corp., and F. D. Forrest, testing engineer for the same company. Forrest, who presented the paper, described field testing methods used by California Research Corp.

In field testing an oil, he said, either new or reconditioned engines are used to insure properly fitted parts. Oil is changed periodically (every 1500 miles for a 7000-mile test). When the test is completed, at the engine overhaul period, the engine is disassembled and its parts inspected and photographed.

Inspection results for each engine are tabulated, with code numbers used to indicate condition of the parts. For example:

GD number (piston groove deposit) ranges from 0 (good) to 100 (bad); and PD number (piston deposit) ranges from 0 (good) to 800 (bad).

Tabulations for those engines using the same type oil are averaged and the results made into another table, along with those of other oil type runs, for comparison.

Diagnosis of engine troubles showed, among other things, that lacquer or carbonaceous deposits result from oxidized oil that is caused by unstable oil, high temperatures, incorrect oil change interval, oil consumption, and so forth; sludge derives from water, is caused by low-temperature operation; ring sticking comes from improper mechanical clearances or sludge; and bearing corrosion comes from peroxides and acids caused by corroded oil, fuel dilution, high temperatures, and high local pressures.

Changes in the base stock and the material compositions for oils, Forrest

AUTOMOBILE CATCHES FIRE!

The Department of Safety, American Petroleum Institute, included the following in a February, 1947, bulletin:

"A car was driven into a service station for gas and the engine was left running while the station attendant filled the tank. During the operation the engine almost stopped running and the driver choked it, causing the engine to back-fire and burst into flame.

"The car was destroyed by the fire and the occupants were badly burned — *one fatally.*

"It is an unsafe practice to allow the engine to run while getting the tank filled with gasoline."

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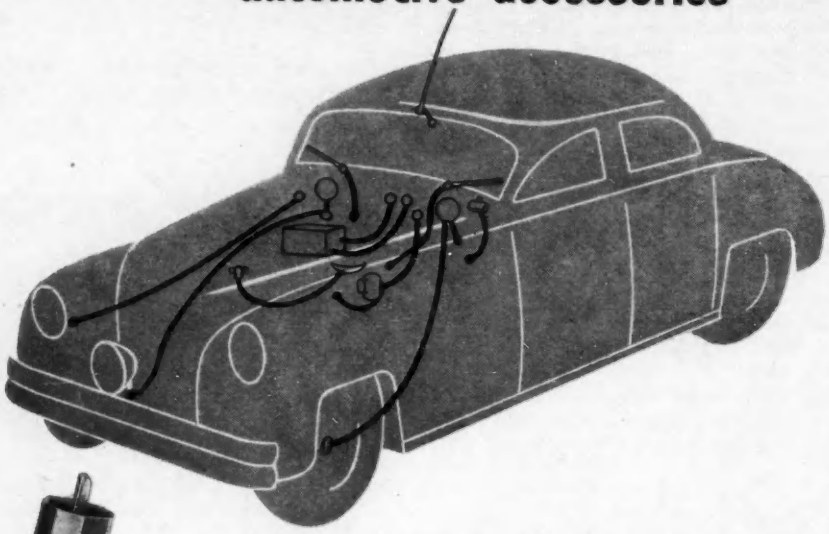

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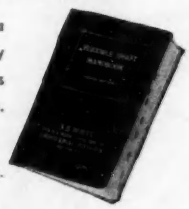

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said, produces results varying from very good to very bad. Of course the goal is to produce oils that will lower engine operating costs.

Discussion following his talk brought out these points:

- Purpose of a detergent is to reduce deposits regardless of whether or not a filter is used.
- Assuming no foreign particles (such as dust) are introduced into the oil, a filter is not very effective until the composition oils begin to oxidize.
- Particles removed by the detergent are small enough to be kept in suspension, and will pass through a filter.
- Foreign material is usually not taken care of by detergents because particle size is larger.
- In compounding oils, it is sometimes necessary to change the base oil to gain the desired results.
- Oils compounded by different companies are compatible when they are designed within the same Government specifications.

C. C. Moore, of Union Oil Co.'s research department, and his assistant W. L. Kent prepared the subject "The Effect of Nitrogen and Sulfur Content of Fuels on the Rate of Wear in Diesel Engines." Moore talked on the test methods used in determining the effects of sulfur, nitrogen, and acids.

The engine used in these tests was not dismantled after each run. Introducing a new oil compound for test simply meant draining the engine, filling with the "new" oil, running the engine several hours, draining, refilling with a fresh supply of the "new" oil, and finishing the test. At the end of the test, a sample of oil was taken from the engine and its iron content determined. Iron content indicated how much engine wear had taken place.

From test results, he said, it was found that the presence of nitrogen and/or acids produced little added engine wear. Engine wear, however, was considerably increased when sulfur was present in the lubricating oil, but this effect was damped by operating at higher jacket temperatures.

Report Progress On Mobile Radio

by GENE O'HAIRE, Field Editor

MOHAWK-HUDSON Group, May 20—A two-part report on the work of the Committee on Radio Communication Suitable for Automotive Fleet Application was presented at this meeting by Wesley C. Baylis, New York Power & Light Corp., and C. F. Meyer, General Electric Co. Baylis discussed installation and use of radio equipment, covering problems of space requirements, battery and generator requirements,

ignition interference and so forth. (See SAE Journal, March, 1947, p. 43.)

Meyer reported on the history of mobile radio-communication, frequency allocation, and the availability of the frequencies to various service. Originally, he said, law enforcement agencies – chief users of mobile radio – used frequencies just above the standard broadcast band, from 1610 to 1730 kc, and from 2326 to 2490 kc. Performance paralleled that of car radios: reception was good during the day up to about 50 miles, and was little affected by hills and valleys; nighttime operation encountered severe interference from other stations, thunderstorms, ignition systems, and other noise-makers.

Improvement has been hampered, Meyer said, because FM has not been applied to the medium frequency bands, and it is difficult to build an AM, or amplitude-modulation, transmitter for the medium frequencies. AM requires a more elaborate and bulkier transmitter, with greater current drain, than an equivalent FM transmitter. And, he said, the theoretically correct antenna for a mobile transmitter operating on 1600 kc is 154 ft long.

Further investigations of radio wave propagations at very high frequencies, in the 30 to 42 mc region, showed that these waves travel in an almost direct line of sight, and that 7-ft antennas were sufficient. With FM, proved in 1939 to be better than AM for broadcast and emergency services, coverage ranges up to 30 miles were achieved, with almost no noise or interference. Wattage, too, could be reduced at central stations.

Application was limited to police, marine, fire, forestry and special emergency use because available frequencies were limited. Interference increased after 1943 as the 30 to 42 mc band filled with stations, and lead to investigation of frequencies still higher. A new frequency allocation plan grew out of cooperation during World War II of the FCC, Radio Manufacturers' Association and other advisory groups. Creation of new channels for general use increased the list of services that could use frequencies. Better equipment and greater knowledge carried good performance far beyond previous limitations.

New allocations – from 72 to 76, 152 to 162, and 952 to 960 – were added to the 30 to 42 mc band. The first gives less coverage than the lower band, but also less skywave interference. Antennas are about half the length. Chief drawback is that it is sandwiched in between two television channels and creates interference in them.

The 152 to 162 band has almost no skywave interference, and gives better performance in built-up urban areas than the 30 to 42 band. Many dead spots are eliminated, but range is more limited, and short waves will not bend around hills as well as longer ones.

Little equipment is yet available for the 952 to 960 band; this is established primarily for relay or repeater stations used for rebroadcasting of signals and for point-to-point work. Waves at this frequency behave almost exactly like light waves. Antennas are about 3 in. long. Technique is analogous to that for radar, and there are sharp limitations to its use for mobile work, since shadows thrown by buildings and terrain would make reception impossible anywhere except in sight of station antennas.

FCC assignments in the 152 to 162 mc band, Meyer said, can be made to police, fire, relay broadcast, geophysical, forestry-conservation, relay press, motion picture, power and petroleum utilities, general mobile urban, provisional and experimental (including taxicab), rural radiotelephone and other common-carrier telephone services, maritime mobile, special emergency, and railroads. In the 72 to 76 and 30 to 44 mc band, the same services are authorized for frequency assignments, and transit utilities added to the list.

New FCC rules indicate a tremendous expansion in use of mobile radio, as experience is gained by its users. Improvements never outrun demands for more improvement.

Boston Transit Plans Explained at Section

by ARNOLD R. OKURO, Field Editor

NEW ENGLAND Section, May 13 – Boston will have rapid transit facilities extending to points some ten miles from the center of the city, if a plan reported at this meeting meets with approval. Lt.-Gov. Arthur W. Coolidge told SAE members that proposed legislation would create a Public Authority to acquire the properties of the Boston Elevated and run the system as a public utility.

This would result in savings of approximately $1,750,000 per year through elimination of dividends and taxes.

The proposed system, he said, includes eight major extensions. The report concludes that the entire system, when in effect, could be self-sustaining without deficits. Report includes details of construction, type of motive power, type of cars and trains to be used, running times, and fares.

Extensions to the present system would come as required by needs of communities along the various proposed routes. The whole plan would take at least 10 years in planning and construction.

Besides servicing 2,500,000 people in the metropolitan district with cheap, adequate and convenient transportation, Coolidge said, the plan offers much-needed relief to areas of the city now congested with automobiles.

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This is the story...

"A drum of Stuart's THREDKUT 99 was purchased by this company to be used for a test on threading type 304 stainless steel pipe nipples. A supposedly sulphurized oil was previously used, but it just could not do the job—most of the threads were badly torn. *Upon changing to THREDKUT 99, excellent threads were obtained*... a repeat order has been placed, and they plan to use it regularly."

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Hydraulics Spans Automotive Field

by W. F. SHERMAN, Field Editor

DETROIT Section, April 21 – An appraisal of the possibilities of power hydraulic equipment in relation to automotive applications was offered at this meeting by Merrill A. Hayden, of Vickers, Inc.

He characterized the development and application of principles of high pressure hydraulics to transmit, apply and control power as one of the most universally useful engineering advances.

Addressing a session of the Truck and Bus Activity he said that the trend to hydraulic installations is being investigated by many engineers in the truck, bus, tractor and passenger car fields. Investigators are finding out that power can be efficiently delivered to points anywhere on the vehicle without gears, shafting, belts, clutches, linkages or other mechanical connections. Up to 25 hp can be delivered through half-inch tubing.

Among advantages of power hydraulic equipment, he cited the fact that it provides overload protection automatically and that it will tolerate a stalling load indefinitely without damage.

He discussed use of a hydraulic power package suitable for operating agricultural implements, attachments and harvesting equipment. These units consist of a vane-type pump, filter, automatic safety valve, and one or more control valves for manual operation – all packaged in a single housing which serves as the oil reservoir.

"Power steering for automotive vehicles has been accomplished successfully only by the hydraulic method," he stated. "Hydraulic power steering is not new in itself – ship steering has been done hydraulically for years, and the background of power steering in automotive work is as long and as successful as that of the power hydraulic industry. But its field of application has now been widened with the introduction of a redesigned system with which increased production has resulted in lower cost."

The hydraulic units which he described for a power steering system consist of a pump, a steering booster assembly incorporating a hydraulic cylinder, a servo control valve, a safety overload valve and a check valve. He described a typical installation. In it the pump is unloaded when no actual steering is being done. During the steering, oil pressure corresponds to actual steering load.

A totally new power hydraulic development which de described consists of a system for brakes, clutch, windshield wipers, doors, torque converter controls, shutter controls and other devices on trucks and buses. An installation in regular transit bus service for 20 months was described and illustrated.

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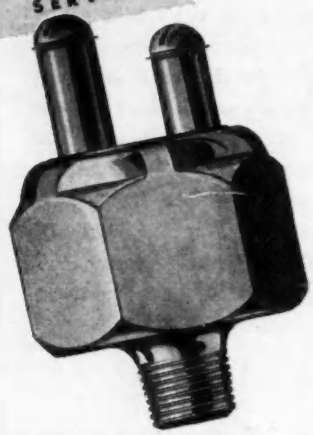

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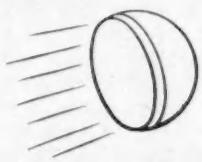

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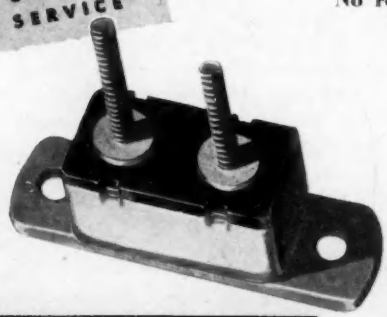

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About SAE Members

cont. from p. 77

HAROLD G. B. PERRY, who recently retired from Standard Vacuum Oil Co., England, has organized the Sinim Engineering Corp., 81 Jinkee Road, Shanghai, China. The firm will serve as industrial and consulting engineers and will represent Occidental business interests in Asia.

E. F. RUETER has been named to the post of chief engineer with the

Unit Crane & Shovel Corp. in Milwaukee. He received his training at the University of Wisconsin and after 17 years of active engineering experience at the Kowhring Co., joined the Unit staff in 1944.

Recently vice-president in charge of engineering for Aireon Mfg. Corp., **RALPH MIDDLETON** has joined Weston Hydraulics, Ltd., North Hollywood, Calif., as engineer in charge of production. He is one of the industry's leading designers of aviation hydraulics. In the past he has been associated with Curtiss Wright and also was chief of the Hydraulics and Alighting Gear Laboratory at Wright Field.

PROFESSOR F. H. EMERSON has recently returned to Wayne University as associate professor of mechanical engineering after spending two years in Tucson, Airz.

Appointment of **JOHN OSWALD** to a newly created executive engineering post with the Ford Motor Co. has been announced by **HAROLD T. YOUNGREN**, vice-president and director of engineering. An engineering executive for many years, Oswald will serve Ford as executive engineer of styling and body engineering.

HARRISON L. HART announces the opening of his new offices at 919 North Michigan Ave., Chicago.

No longer an automotive engineer with the Standard Oil Co., Mason City, Iowa, **WALTER L. MacARTHUR** has become sales representative in the state of Iowa for the Sta-Vis Oil Co., St. Paul, Minn.

Until recently in the employ of Messrs. Humber, Ltd., Coventry, England, **D. C. NEAVES** has now taken the post of senior technical assistant in charge of Chassis Development with Messrs. Armstrong-Siddeley Motors, Ltd., also in Coventry.

W. E. DAY, Jr., has become director of the Research Division, Mack Mfg. Corp., Plainfield, N. J. Previous to this post he was a metallurgist with the above company in New Brunswick, N. J.

Now serving as an engineer with Dearborn Motors Corp. in Detroit, **LOREN E. BARTLING** had been affiliated with the Ford Motor Co. in Dearborn.

AUBERT MARDEN RICE, JR. has recently accepted the position of sales engineer for the Cee Bee Chemical Co., Inc., Los Angeles. Prior to this post he was production engineer for Northrop Aircraft, Inc. in Hawthorne, Calif.

Previously a chief metallurgist with the Beech Aircraft Corp. in Wichita, Kans., **HOWARD A. SMITH** is now research chemist for the Fansteel Metallurgical Corp. in North Chicago.

Recently relinquishing his position as vice-president of Photocon Research Products in Pasadena, Calif., **HENRY F. SCHULTZ** is now research design engineer at the American Wheelabrator & Equipment Corp. in Mishawaka, Ind.

D. L. WADSWORTH is no longer chief inspector of the Experimental Division at White Motor Co., Cleveland, He recently accepted the post of quality engineer at the Towmotor Corp., same city.

FRANK T. COX, JR., has become chief test engineer at Mack Mfg. Corp. in Allentown, Pa.

Until recently power plant analyst at Republic Aviation Corp., Farmingdale, L. I., N. Y., **FRANK J. HART** is now manager of Towne Motors, Inc., in Linden, N. J.

ROBERT KING HIRCHERT is assistant resident engineer, Chevrolet-Flint Assembly, Flint, Mich. Prior to this post he was production engineer in

Wyman-Gordon has originated and developed many forging designs in steel, aluminum and magnesium and has pioneered in the development of proper grain flow. . . . Typical of such a development: an aluminum alloy piston forging.

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HARVEY, ILLINOIS - DETROIT, MICHIGAN

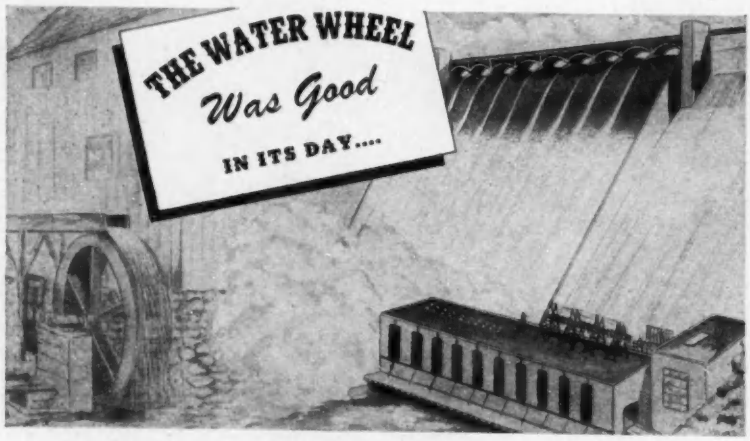
the Chevrolet Central Office, Detroit.

Having relinquished his position as senior engineer, Flight Research Department at the Cornell Aeronautical Laboratory, Buffalo, N. Y., **JAGANNATH P. CHAWLA** is a research assistant and a graduate student of aeronautical engineering at Massachusetts Institute of Technology, Cambridge, Mass.

Recently becoming chief engineer at the Anker-Holth Mfg. Co. in Port Huron, Mich., **BURNELL O. BURRITT** was formerly chief hydraulic engineer with the Progressive Welder Co. in Detroit.

HAROLD O. MOELLER recently became a special representative for the Key System Transit Lines in Oakland, Calif. Previously he was division service manager of the Central and South West States for Mack Trucks, Inc., Chicago.

Heretofore a test engineer for the Kiekhaefer Corp. in Cedarburg, Wis., **HERBERT KOEHLER BROWN** has accepted a similar position with Tillotson Mfg. Co., Toledo, Ohio.



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Student Branch News

cont. from p. 80

detail. Its rated thrust is 4000 lb. It weighs about 1800 lb, and is 102⅞ in. long and 51 in. in diameter. An estimated 300 lb could have been saved by using magnesium instead of aluminum and steel where structurally feasible, he said, but this saving was ruled out because of the danger of magnesium burning under some of the temperature conditions encountered.

Unique feature of its design is three-point mounting. Two horizontal trunnions on the sides and one ball support below and behind the engine are the only points at which it is structurally attached to the fuselage. This permits unusually rapid engine changes; times of 8 min have been turned in. In addition, the ball support permits rapid alignment in the craft.

About 1/3 of the engine's weight is concentrated in the rotor assembly. This consists of the compressor blades (30 in. diameter), the impulse turbine blades, and the connecting shaft, which has a splined joint to permit axial play between the two blade assemblies without interfering with the transmission of torque from one to the other. Rotor rpm is 11,500. An extension of the rotor forward of the compressor powers the accessories.

In addition to the usual array of accessories to be found in any aircraft engine, there are a few peculiar to this engine that bear description. Since the speed of the engine is controlled directly by the amount of fuel pumped, a simple control on the fuel system is the only throttle control necessary. This and the starter are the only engine controls the pilot has to use.

Since fuel requirements for a given rpm are lower at high altitudes, an ingenious device called a barometric automatically compensates for altitude. A pair of bellows is mounted opposing each other. One is sealed at ground level, and the other left exposed to changing atmospheric conditions.

At high altitudes, the sealed bellows expands against the other, and this displacement operates a control that bypasses a corresponding amount of fuel from the supply system back to the tank, thereby keeping the net supply down to the amount required. A similar bypass attached to a governor keeps the engine speed down to a desired maximum.

Unlike other aircraft engines, jet engines have to gear down from engine to accessory speed. In the I-40, the ratio is 11,500:3500.

Combustion chambers are connected at their forward ends so that only two spark plugs (used only for starting)

are necessary; in case one chamber "goes out" during operation, the adjacent one would relight it.

The use of a long tail cone behind the engine reduces the turbulence of the thrust-producing exhaust gases. Had this feature been possible in the P-80, its performance would have been even better.

Heldack drew some interesting comparisons with conventional planes; for instance, jet thrust does not vary greatly with speed of the plane. This means a longer take-off run, but gives a good accounting at high speeds.

At a speed of 550 mph, the I-40 is equivalent to a 7340-net-hp prop-driven engine. Warm-up time is effectively cut to zero because initial warmup actually can be the take-off run. In addition, jet engines have been found through exhaustive tests to be slightly less vulnerable in combat than conventional powerplants.

After a short question period, the group adjourned to another part of the building where they saw a full-scale cutaway model of the I-40 on display through arrangement with the Army Air Forces at March Field.

Summer Meeting

cont. from p. 30

Ready for use in the rocket, fuel and oxidant may be blended together and carried in one compartment as a single fuel; or fuel and oxidant may be carried in separate compartments. The monopropellant is susceptible to violent detonation. The bipropellant creates the problem of properly metering the flow rate of the two fluids to avoid combustion inefficiency resulting from one fuel being used up before the other.

Some bipropellant systems simplify motor construction by eliminating a need for separate ignition. Oxidizer and fuel ignite spontaneously upon contact in the combustion chambers.

Perhaps all of these troubles akin to conventional chemical reactions may disappear with the advent of a practicable atomic energy system to accelerate charged particles.

Transition from combustion inside the powerplant to what it delivers in return took the form of a graphical preliminary analysis for estimating performance characteristics of simple-cycle turbojet and turboprop engines. It was said to aid the engineer in tailoring the powerplant and airplane to each other so that the best possible combination results. A case in point is the addition of the engine weight for a specified maximum speed plus the fuel and tankage weight for a specified range to indicate the best generator and propulsion system.

Increased powerplant flexibility was said to result from combining a constant-speed propeller-driven engine with an open-cycle jet-propulsion gas turbine in a design including the good points of each.

Although having possibilities for large high-speed transports, the combination is now being applied to military aircraft, such as the Navy Fireball (FR-1), where short bursts of high speed are particularly important.

The jet engine, as is well known, uses fuel at a tremendous rate, cutting down range, and must operate at high speeds to maintain power. The maneuverability of a jet fighter is limited in combat, where the ability to accomplish slow-speed climbs and tight maneuvers (at speeds slow enough to keep within the load factors of the plane) is important. These disadvantages are said to be eliminated in the composite-powered plane, which flies on the piston engine most of the time and uses the jet engine for take-off and short bursts of high speed.

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Car Features Occupy Standards Groups

cont. from p. 82

to measure and record stopping distance. T. J. Carmichael, of General Motors Proving Grounds, described an acceleration-time integrating decelerometer that he believes will give an accurate indication of retardation effectiveness.

These and other problems are obstacles the group feels it must hurdle before it can come up with a satisfactory quick brake test.

A word of caution was sounded regarding performance tests of brakes in operators' hands – not to compare tests made on brand new cars with tests on cars with 3000 or more miles.

The search for explanations of fundamental vibration concepts in terms of greater car-riding comfort is being continued by the SAE Riding Comfort Research Committee. In a report issued last year, "Ride and Vibration Data," the Committee set forth simple mathematics for determining simple harmonic motion and energy absorption of springs under acceleration, impact, and constant velocity.

At a recent meeting, Chairman R. W. Brown, Firestone Tire & Rubber Co., said that in addition to the group's present studies of human tolerance to vertical vibration, consideration should be given to instrument development.

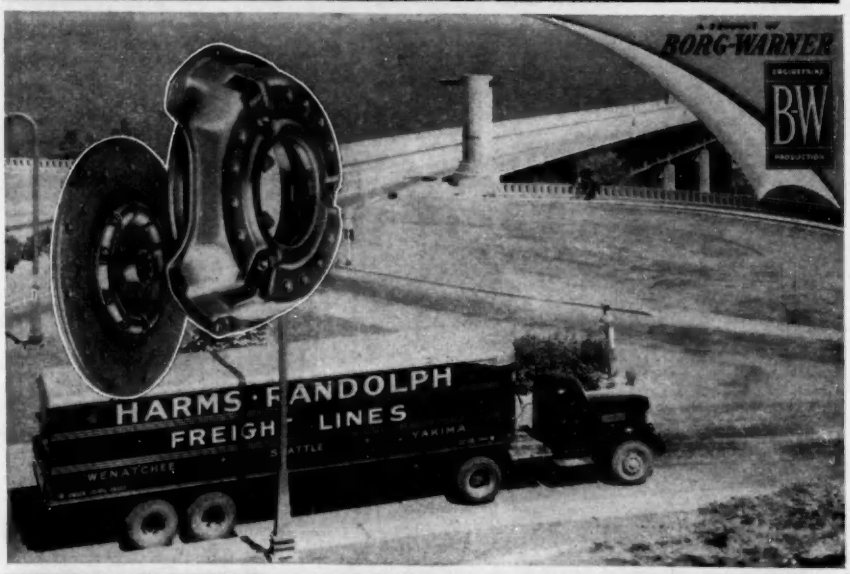
He feels that the design engineer, like the doctor, needs a stethoscope – a ride stethoscope. A single instrument of this kind is sorely needed to tell what happens to ride characteristics of a car in day-to-day driving. Whether such device can be incorporated into a single unit is a moot point.

Just as elusive is determination of the point at which the human body becomes intolerant to vertical vibration – the threshold of discomfort. According to R. N. Janeway, Chrysler Corp., who analyzed and correlated all existing experimental data and literature on the subject, such a study is rife with variables. Cushioning of both the car seat and human anatomy alters vibration transmission to parts of the body.

Janeway felt that taking measurements on the subject's head or shoulder might eliminate the varying influence of cushioning so that some agreement in tolerance could be obtained.

In a summary report to the Committee, he said that the vibration characteristics which control human discomfort vary with the frequency range—starting with "jerk" in the lowest range, changing to acceleration in the middle range, and depending on velocity in the highest range.

ROCKFORD



SPRING – LOADED
CLUTCHES

LIGHT PEDAL PRESSURE
CUSHIONED ENGAGEMENT
VIBRATION DAMPENING
ACCURATE BALANCE
DIRT EXCLUSION
HEAT DISSIPATION
LIFETIME ADJUSTMENT

* The life of ROCKFORD Spring-Loaded CLUTCHES is lengthened by the design of their cover plates. This feature provides maximum ventilation for the clutch. The openings in the top and sides supply a flow of air that promotes cooling and the escape of dirt and dust from the clutch. This life-lengthening cover design is one of several ROCKFORD advantages.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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Applications Received

The applications for membership received between May 10, 1947, and June 10, 1947, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section: Marcel Albert Lamoureux, Sigurd Nelson.

Canadian Section: William G. Belfry, James Irving Carmichael, George M. Davies.

Chicago Section: Bjorn F. Benson, Donald S. Berry, Virgil M. Exner, Rudolph A. Holmberg, Lloyd A. McCormick, Frank J. Pryatel, John W. Queen.

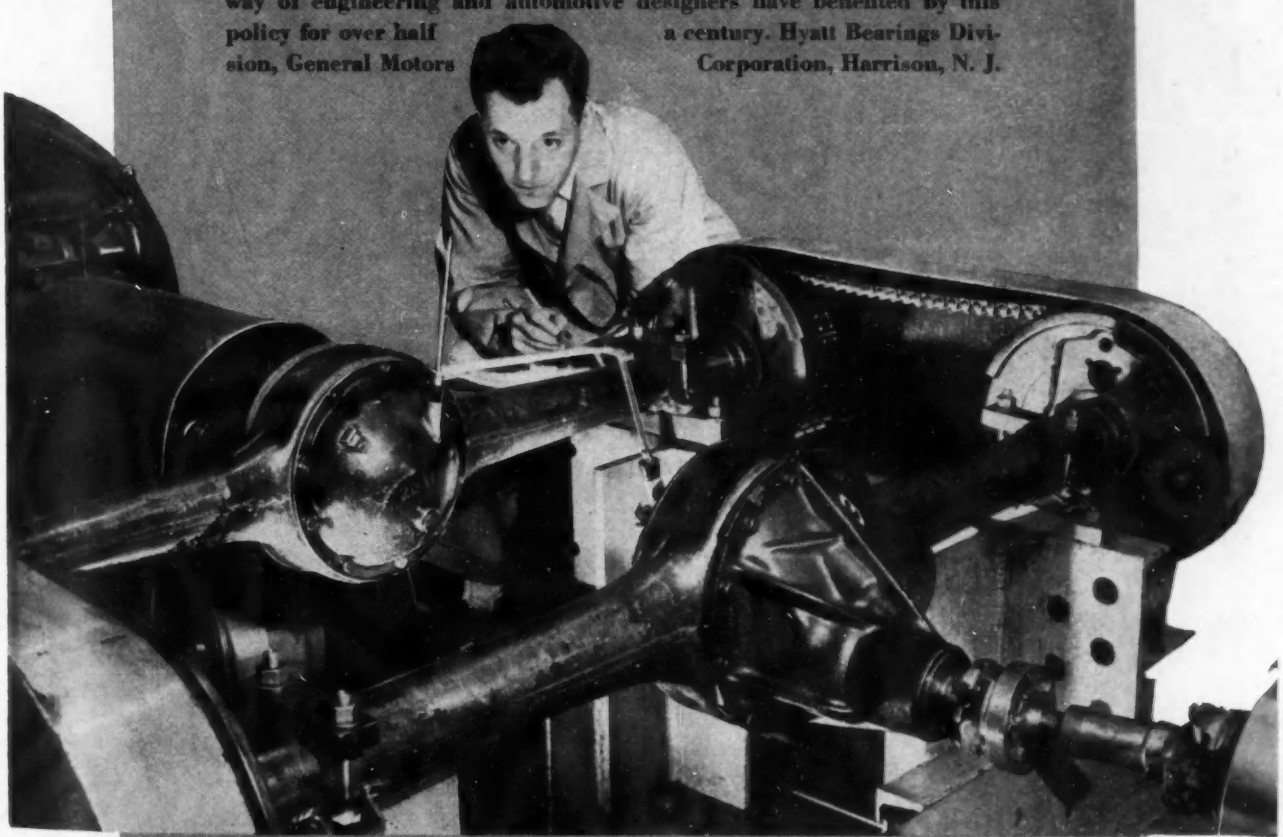
Cleveland Section: Glenn W. Bailey, Hugh S. Highet, Norman Frank Jirousek, A. R. Klingel, Heber C. Lamar, Charles

MOUNTAINS
MADE TO ORDER

—Big mountains. So big that a car driving up the side could travel only 35 mph even with the accelerator wide open.

A real test for a car—particularly the bearings in the rear axle; which is why Hyatt engineers designed and built this test rig that reproduces, mechanically, these driving conditions. For, although long life and care-free operation are designed and built right into Hyatt Roller Bearings, these qualities are not taken for granted. They are proved by regular process inspections through every step of manufacture—and by specialized endurance tests like this, of bearings picked at random from regular production.

This is just one example of our policy of "individualizing" Hyatt Roller Bearings to the work they have to perform by projecting the conditions of ultimate use into their design, materials and manufacture. Fitting the bearing to the job—not the job to the bearing—is the Hyatt way of engineering and automotive designers have benefited by this policy for over half a century. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.



HYATT ROLLER BEARINGS

B. Mallett, Arthur F. Neubrander, Reino J. Niemela, Domenic A. Petruccio, Howard C. Worden.

Dayton Section: G. LaVerne Runkle.

Detroit Section: W. J. Allard, Frank F. Braun, Leonard F. Burke, Charles F. Dye, Jr., Leon C. Greene, Frank W. Hartman, Jr., Hal A. Livingstone, James McCracken, W. H. Messner, Eric Ramstrum, Donald F. Reynolds, Ray C. Sackett, William H. Taylor, William C. Vincent, George H. Wetterhahn, Richard H. Wheeler, Jr.

Hawaii Section: Daniel W. MacMillan, Alfred Nunes, William Waring Ruddock, Takeo Shibuya, John A. Taylor, John Edgar Walker.

Indiana Section: W. E. Brown, Raymond L. House, LeRoy Ware.

Metropolitan Section: Victor R. Allen, Anderson Ashburn, Myron H. Bell, J. Douglas Bennett, Walter R. Bush, Peter Henry Cerf, John S. Drake, Frederick H. Flagg, Zola Fox, Alan B. Gorman, Andrew P. Gregg, Joseph P. Haworth, Berhard Lieberman, Joseph J. Mancusi, Jr., Frank E. Mott, David Chester Noyes, Jr., Aubrey Pershouse, Fred M. Peschel, Robert R. Porter, Manuel Unterman, David J. Seigel, Walter C. Teagle, Jr., Guglielmo M. Ventimiglia, Douglas Courtenay Watson, Harry E. Zust.

Milwaukee Section: Tom Burress, J. A. Fries, Frank C. Gokey, H. V. Kilpatrick, Lionel Drew Thompson.

Mohawk-Hudson Group: James C. Gallagher, T. G. Milton.

New England Section: Frank Alward, Kenneth M. MacDowell.

Northern California Section: Stuart F. Alsott, Robert B. Pimberton, Alexander P. Stikkers.

Northwest Section: Kenneth E. Fosnes.

Oregon Section: Edward A. Haas.

Peoria Section: Robert Stuart Dike, Delmar C. Klawitter.

Philadelphia Section: Rudolph Birmann, R. Carter W. Jones.

Pittsburgh Section: Wayne W. Carter, H. A. Klein.

St. Louis Section: Kenneth C. Baker.

Salt Lake City Group: Robert Derrill Taylor.

Southern New England Section: Donald Adams, Steve A. Beisert, Jack Thomas Belasco, Henry T. Clark, Leland E. Copple, W. A. Cummings, Herman S. Fleck, R. R. Hootman, John Loprich, Eugene Glen McLaughlin, A. H. Moore, Frank O'Neill, George H. Powell, John H. Shandorf, Henry G. Smith, Jr., Jay William Stuart, Jr., Charles G. Wright.

Southern New England Section: Donald Peard Kay, Milton L. Gearing, John V. Moffitt.

Spokane Group: Ray J. Prosser.

Texas Section: Lee P. Livingston, Harry D. Miller, Jr.

Virginia Group: Grayson A. Brock.

Western Michigan Section: Robert H. Sanborn.

Wichita Section: Harold Robert Dobb, G. D. Hendrick, H. A. Mayor, Jr.

Outside of Section Territory: Virgil L. Ackerman, Ervin V. Andrews, Jr., James Arthur Bancroft, Harry A. Bishop, David Holland Bradford, Jr., Wendell Cooper Compton, Thomas W. Holt, Jr., Max H. Leavenworth, Wesley R. C. Melyan, Dudley W. Watkins, Jr.

Foreign: Joseph Edward Bott, England; Eric James Dunstan, England; Charles Fletcher, Australia; Harry James Harris, England; Douglas Price-Stephens, England; John Watson Thorburn, England; Harold William White, England; Aatto Aleksi Wuorela, Finland.

New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between May 10, 1947, and June 10, 1947.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section: William B. Shippen (J).

British Columbia Group: Arthur R. Brown (A), Frederick Myles Herbert (A).

Buffalo Section: Robert G. Lyon (M).

Canadian Section: Burton Jenner Bourchier (A), Gordon William Bouskill (A), Stanley R. Patience (M), Charles P. Short (A), Edwin Charles Tucker (J).

Chicago Section: Albert E. Kraus (M), Robert C. Walter (J).

Cleveland Section: James J. Rataiczak (J), Marvin Clemens Riggert (M), Elmer Van Sickle (A), William Malcolm Walker (J).

Dayton Section: Delco Products Div. (Aff) Reps: J. I. Anson, R. I. Bates; Lewis H. Davis; Stephen P. Malone; C. J. Werner, Paul D. McMahan (SM).

Detroit Section: Charles Town Alexander (A), Wallace Winfield Edwards (J), J. Dean Garrett (J), Leroy H. Hull (A), John Oldham Huse (M), John F. Jones (J), Robert T. Lukens (J), Austin G. Stecker (M), Frederick H. Stocker (J), John Taylor (A), Clark A. Tea (M), Gerald J. Theunick (J), Lawrence A. Werth (J), Edward J. Zauel (M).

Hawaii Section: Charles A. Devine, Jr. (A).

Indiana Section: Ivan E. Calicoat (M), C. A. Payntor (M).

Metropolitan Section: John H. Collins (A), A. B. Culbertson (M), William Garber (J), Roswell N. Hait (A), John William Motzer (J), Leon Resnicow (J), Henry G. Steinmetz, Jr. (M).

New England Section: Sol Marder (J).

Northern California Section: Thomas R. Hare (J), Esko A. Hofmann (A), Arthur R. Isitt (M), Richard A. Ray (A), David M. Saenger (J).

Northwest Section: Robert A. Holmstrom (J).

Oregon Section: William Edward Nunnenkamp (A).

Philadelphia Section: Henry B. Griffing (J), Maximilian J. Palena (J).

Southern California Section: Orien L. Hogan (J), Edward Thomas McKain (A), Wesley W. Smith (M).

Southern New England Section: Armand Bosco (J).

Syracuse Section: Wilber R. R. Winans (A).

Texas Section: Penn E. Mullowney (M), Col. Carlton P. Smith (SM).

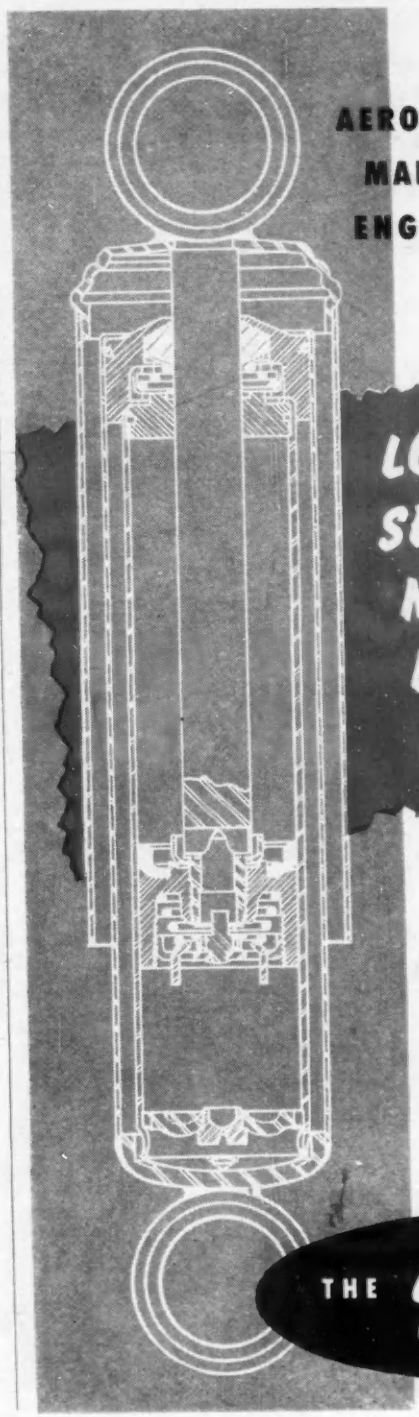
Virginia Group: George C. Valentine (A).

Washington Section: James Bernard Jones (A), Morrill Boughton Spaulding, Jr. (M).

Wichita Section: Merle Francis Jackson (A).

Outside of Section Territory: C. W. O. George Edmond Fisher (A), Wilfred E. Slade (M).

Foreign: Robert Hardie (FM), England; Rene Lucien (FM), France; Ralph L. Noyes (FM), India; Johannes Martinus De Kock Schutte (FM), So. Africa; Gerald Edgar Stevens (FM), Australia.



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A qualified Gabriel ride engineer is as close to you as your telephone.

THE Gabriel COMPANY
CLEVELAND 6, OHIO

Car Engine in Planes

cont. from p. 71

was about $400 – cheaper than other engines of comparable horsepower.

This engine produced 63 hp at 2135 rpm and its installation weight, including radiator and coolant, was 305 lb.

But its service difficulties were legion. Some of the 100 engines sold experienced major failures during their delivery flight to the customers; others gave 700 to 800 hr of trouble-free operation.

Most obvious disadvantages of this engine were:

1. Extremely heavy weight because of the automotive design and liquid-cooling;

2. Mechanical failure of parts which could not be altered without boosting the low price – only justification for the engine;

3. Failure to convince both sales people and management that low-priced automotive replacements could not be used in the engine. Many parts looked like their automotive counterparts. This practice led to many failures. (Paper "Experiments with Converted Automotive Engines for Light Aircraft Powerplants," was presented at SAE Personal Aircraft Meeting, Wichita, May 2, 1947.)

Proving
AIR-TIGHT CONSTRUCTION
Making an air cleaner air tight is essential. A leak would allow dusty air to by-pass the oil washing process and enter the engine. To insure air-tight construction, Donaldson Air Cleaners are given this underwater pressure test. The air cleaner is mounted on a specially built machine, submerged in water, and air pressure is introduced at 15 pounds per square inch. Any leak can be detected instantly by tell-tale bubbles.
This test is only one of many made in the Donaldson laboratories, in their plants and in the field to assure you proved protection against abrasive dust.
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AIR CLEANERS

See Robot Controls For Future Planes

Digest of paper

By HUGO SCHUCK and GORDON VOLKENANT

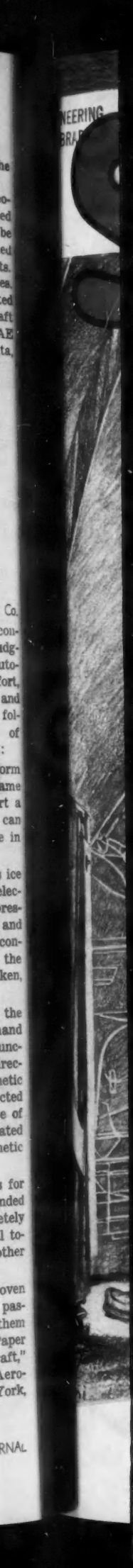
Minneapolis-Honeywell Regulator Co.

THE trend toward push-button controlled airplane flight is certain, judging from achievements to date in automatic controls for engines, comfort, flight, and navigation, Schuck and Volkenant believe. They offer the following examples as harbingers of automatons for tomorrow's aircraft:

Automatons can effectively perform safety functions. An electronic flame detector can detect a fire and start a fire extinguisher. Then a signal can tell the pilot, "You just had a fire in Number 1 engine!"

An even more insidious danger is ice on the wings. A little single-tube electronic ice detector can sense the presence of a critical thickness of ice and warn the pilot. Additionally it can control boots or deicing heat without the pilot's attention. By the same token, windshield ice could be prevented.

Acceptance of the autopilot as the main flight control brought a demand for incorporation of even more functions. Slaving the autopilot's directional gyroscope to the magnetic compass gave continuously corrected heading control. Taking advantage of the gyroscope's "memory" eliminated fluctuations and errors of the magnetic compass.

Using instrument landing beams for automatic approach has been extended experimentally to allow completely automatic, hands-off landing. Will tomorrow's aircraft have these and other automatic controls?

Yes. As soon as their value is proven in terms of safety, economy, and passenger comfort, more and more of them will become standard equipment. (Paper "Automatons for Tomorrow's Aircraft," was presented at SAE National Aeronautic Meeting (Spring), New York, April 9, 1947.)